E4E
Education for Engineering

OPPORTUNITY OR ABILITY?

Key Stage 4 science and mathematics participation and attainment in England 2010

Acknowledgements

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Executive Summary

The UK must ensure it has an adequate supply of people working in science, engineering and technology roles to meet the needs of industry and the wider business community. The key first step to achieving this is to ensure that sufficient numbers of pupils are participating in and achieving good GCSEs or equivalent qualifications in science and mathematics at the age of 16.

However, this report by E4E shows that a significant proportion of young people in England are not attaining good enough grades in the necessary qualifications to enable progression to science, engineering and technology careers. There is also strong evidence to suggest that many pupils across England are not even being given the chance to achieve their full potential in science subjects.

Given that participation and success in Triple Science GCSEs is an indicator of future attainment in science subjects[1], our research shows that young people's potential to progress in Science, Engineering and Technology is currently heavily determined by opportunity rather than ability.

This report presents the results of an analysis of the entry and attainment of pupils in mathematics and science subjects at the end of key stage 4 in 2010 in England. It provides a snapshot of the potential pool from which the economy can draw its Science, Engineering and Technology future workforce.

The study does not consider the underlying factors contributing to variation in participation and attainment such as pupil characteristics; gender, ethnicity and socio-economic status. However, the findings show there are many areas across the country where there is significant industrial presence, yet high proportions of pupils are not being given the opportunity to achieve their full potential in sciences because they are not being offered triple science qualifications and too few are achieving the minimum requirements for progression in science, engineering or technology.

Progression in science, engineering and technology invariably requires a minimum QCF level 2 qualification in mathematics such as A*–C grade at GCSE. For this report the minimum level of qualifications for progression to further study and/or a career in professional Science, Engineering and Technology (SET) roles is considered to be A*–C grades in at least two science GCSEs (or equivalent qualifications) **and** A*–C in mathematics GCSE. These qualifications would also likely be expected for any person wishing to enter into *professional technician* roles across science, engineering and technology[2]. Attention however is also given to those studying three science GCSEs (or equivalent) as this is known to be the strongest indicator for those likely to pursue a career in SET.

The findings, based on these requirements, give cause for concern for the future supply of people in science, engineering and technology roles.

The key findings are:

National Participation and Attainment in Science and Mathematics

- 82% of the cohort was entered for the minimum requirement (two or more science qualifications at the end of key stage 4). This means that almost one in five young people were entered for fewer than the minimum required number of science qualifications to immediately progress to further study or a career in science, engineering or technology.
- 1 in 12 pupils (8%) were **not** entered for **any** science GCSE.
- Only half the pupils achieved A*–C grade in a combination of the minimum science GCSEs (or equivalent qualifications) whilst also gaining A*–C in mathematics GCSE.
- 18% of pupils were entered for Triple Science (individual Physics, Chemistry and Biology) GCSEs. The vast majority of this group went on to achieve A*–C in triple science as well as A*–C in mathematics GCSE.
- 39% of pupils **did not achieve** A*–C in GCSE Mathematics.

Regional Participation and Attainment in Science and Mathematics

There was significant regional variation in entry and attainment in science and mathematics GCSEs. Across the regions of England sub-divided into 41 smaller sub-regions there is a clear tendency towards a 'Science South'.

1 Maths and science education: the supply of high achievers at A level. Research report 079. Department for Education www.education.gov.uk

2 It is of course possible for any person to re-visit science and mathematics qualifications during post-16 education. However, this report is examining specifically the potential supply of a future workforce in science, engineering and technology roles at the end of key stage 4.

Participation

- The sub-regions of England with the highest number of entries to Triple Science were around the South West and the M4 corridor. There is a 16% variation in proportion of pupils entered for Triple Science across England. The highest was Bournemouth, Dorset and Poole with 27.7%. The lowest, North and North-East Lincolnshire with 11.7%.
- The national average for proportion of pupils **not entered** for any science qualification was 8%. The sub-regions with the lowest participation were Lincolnshire and Rutland – (at 23%) and Merseyside (at 17%).
- Looking deeper at the Local Authority level, there is an even greater (36%) variation in entry to Triple Science, ranging from 39.5% of the cohort in Sutton, Greater London to 3.5% in Knowsley, Merseyside. Encouragingly, localised excellence can however be found across all of England.
- In four Local Authorities, over a quarter of pupils were not entered for **any** science qualification.

Attainment

- Higher proportions of pupils attained science and mathematics GCSEs with A*–C grades in the south of England, particularly in the South West.
- The sub-regions with the lowest proportions of students achieving A*–C grades in two sciences and mathematics GCSEs were North and North-East Lincolnshire (32%) and Merseyside (37%).
- Trafford in Greater Manchester had the highest participation and attainment in science and mathematics of all Local Authorities in England with 67% of pupils achieving A*–C in at least two science subjects and A*–C in mathematics GCSE.
- Blackpool was the poorest performing Local Authority in England for combinations of science and mathematics. Only 31% of pupils achieved two or more science GCSEs combined with mathematics GCSE at grades A*–C.

Participation and attainment in State schools and Independent schools

Comparisons are possible between state schools and independent schools and also between mixed-sex and single-sex schools.

- 44% of all schools in both state-maintained and independent sectors **did not enter any pupils** for Triple Science GCSEs.
- School size was a critical factor. 87% of schools with fewer than 50 in the Key Stage 4 cohort did not enter any pupils for Triple Science. This is almost 1400 secondary schools.
- Girls-only schools had a much higher rate entry to Triple Science, but independent schools had fewer (52%) than girls-only state maintained schools (67%).
- Similarly, boys-only state maintained schools had a higher entry to triple science (43%) than did boys-only independent schools (30%).

The analysis by region and participation by school type and by size suggests that pupils' entry and attainment in Triple Science is often not based on the ability of pupils. Given that participation and attainment in Triple Science GCSEs is a strong indicator of progression in science subjects[3], young people's potential to progress in Science, Engineering and Technology is heavily determined by opportunity rather than ability.

The issue of attainment in science and mathematics in our schools is one which is both national and local. The levels of attainment presented here are not good enough if we are to rebalance the economy in favour of productive and manufacturing industries and compete in a knowledge-led, global marketplace in Science, Engineering and Technology. This issue should be of particular concern for those regions where there is low entry and attainment of pupils in science and mathematics and yet want to attract inward investment from international science and engineering businesses.

Recommendations

To Government

The Government must put in place incentives to increase the number of pupils being entered for Triple Science while also removing potential barriers to greater participation. For example, the English Baccalaureate may act as a disincentive for some schools to pursue Triple Science as opting for Double Science would free up curriculum time for other subjects while still meeting the accountability measure. Careful monitoring is required in order to ensure that the English Baccalaureate does not reduce the engineering and manufacturing skills needed to rebalance the UK economy.

Small schools have fewer participants in triple sciences. Government should monitor participation in triple sciences as the number of Academies and Free schools

3 Maths and science education: the supply of high achievers at A level. Research report 079. Department for Education www.education.gov.uk

increases and take appropriate action if participation in triple science begins to decrease as a consequence of the introduction of these new, smaller, schools.

The Government has done much to improve accessibility of data for the education system in England. However, further efforts should be made to make it easier for schools and policy makers to compare participation and attainment in specific subjects and in combinations of subjects locally, regionally and against national statistics.

To Parliamentarians

The regional and sub-regional variation in participation and attainment in science and mathematics is not only a national issue for the economy, but is also a local issue for MPs. They should be clear that industry will not invest in constituencies where there is no potential workforce skilled in science, engineering and technology to meet its requirements. MPs must act as the local champions for increasing the knowledge and skills of young people in science, engineering and technology. They must work closely with local schools and local industry to improve provision and participation, and where there are shortcomings, they must hold schools to account.

To Industry

Young people need to know why science and mathematics are important subjects for their future. When businesses make closer links with schools, role models and ambassadors must take the opportunity to explain to young people how high attainment in science and mathematics will enhance their career prospects and earning potential.

To Head Teachers

Young people are easily engaged and motivated by the application of science and mathematics. It is in the interest of schools to take advantage of industry support to bring these subjects to life in the classroom. We ask head teachers to make greater use of industry involvement to increase engagement and drive attainment in mathematics and science subjects and to re-examine policies on participation in triple sciences to increase the proportion of pupils taking individual sciences.

1. The importance of engineering skills to the Economy

There has been a growing concern from business and industry for a number of years that while a workforce skilled in Science, Technology, Engineering and Mathematics (STEM) is becoming more important for the UK economy, there is an increasing gap in the supply of people with these skills. The CBI, in its 2012 study[4], found that 42% of member companies are struggling to find employees with STEM knowledge and skills.

There are increasing pressures on the UK to ensure the health, wealth and security of the nation. This includes ensuring sufficient energy supply in the future, meeting carbon reduction targets, developing road and rail infrastructure and introduction of high speed broadband. Engineering skills are also highly valued in other sectors, not just those directly or indirectly involved in engineering. Analysis of the latest research from the UK Commission for Employment and Skills[5] undertaken by the Royal Academy of Engineering suggests that there will be a demand for around 1.3 million workers in science, engineering and technology roles in the next ten years, of which approximately 450,000 will be in technician level roles.

How can this requirement be met? The answer lies in the significant proportion of the UK population of young people and adults who currently do not consider careers in science, engineering and technology or pursue the facilitating subjects which lead to those careers. Increasing the number of pupils who participate and attain good results[6] in science and mathematics at the end of key stage 4, the first formal assessment for qualifications, is a first step to increasing the potential supply of a science, engineering and technology workforce.

The engineering community has been working to better understand the potential supply of and demand for labour for engineering and technology roles. Data on Further Education sector (England) achievements were explored in the Royal Academy of Engineering FE STEM Data reports[7] (2010 and 2011).

This report examines the potential supply of a future workforce in Science, Engineering and Technology (SET) roles by looking at a snapshot of the participation and attainment in science and mathematics subjects in schools.

2. Approach to this research

The analysis presented here draws on the National Pupil Database[8] (NPD) of student attainment held by the Department for Education (DfE). The NPD is an official database of the DfE which matches attainment datasets to school census data to enable detailed investigation of participation and attainment at the level of the individual pupil. This work uses the NPD matched dataset for England to enable detailed investigations of attainment against various measures of pupil characteristics and school types.

4 Learning to grow. Education and skills survey 2012. CBI. www.cbi.org.uk

5 Skills for Jobs: Today and Tomorrow. The National Strategic Skills audit for England 2010. UKCES. www.ukces.org.uk

6 We consider a good result to be A*–C at GCSE or Level 2 in an equivalent vocational qualification

7 FE STEM Data report undertaken by the Royal Academy of Engineering for BIS. July 2011. www.thedataservice.org.uk

8 GCSE results in England are often quoted from Joint Council for Qualification (JCQ) statistics. JCQ data however, includes a substantial number of qualifications achieved outside of schools. Also, JCQ provides figures on individual qualifications, not on, for example, combinations of GCSEs.

This report presents the results of an analysis of the entry for and attainment of combinations of mathematics and science qualifications at the end of key stage 4 where pupils are aged 16[9]. Additionally, it explores take up and achievement of Triple Science GCSE (the three individual GCSEs in biology, chemistry and physics).

The analysis is based on 2009/10 data which was the most recent available at the time of the study. Government policies to promote particular subjects over the last year may well have an impact on 2010/11. For example, recent data from the DfE for shows that entries for Triple Science increased by 4% from 2010 to 2011, in keeping with similar increases for the last five years[10].

3. Requirements for Progression

Progression in science, engineering and technology will nearly always require a thorough grounding in mathematics. For this report this is considered to be a QCF level 2 qualification in mathematics such as A*–C grade at GCSE.

The picture for science qualifications is less clear and requirements are likely to vary across science, engineering and technology sectors and the progression path being taken by the individual[11]. It would be usual for those wishing to progress to a QCF Level 3 qualification in biology, chemistry or physics to have achieved a Level 2 in their chosen science subjects. This may be achieved through studying core and additional science (termed Double Science in this report) or through taking individual Physics, Chemistry and Biology qualifications (termed Triple Science).

For this study the minimum level of qualifications for progression to further study and a career in professional Science, Engineering and Technology (SET) roles is considered to be A*–C grades in at least two science GCSEs (or equivalent qualifications) and A*–C in mathematics GCSE. These qualifications would also likely be expected for any person wishing to enter into professional technician roles across science, engineering and technology[12]. Consideration however is also given to those studying three science GCSEs (or equivalent) as this is known to be the strongest indicator for those likely to pursue a career in SET.

It is also important when discussing progression in engineering to take into account a broad learner experience across a range of subjects, not just mathematics and science. The engineering community recognise and value the contribution of subjects which support an engineering education such as Design and Technology, ICT and Art and Design. Young people should have a broad and balanced curriculum up to the age of 16. In engineering, there are multiple pathways to progression that do not solely focus on the academic route[13].

It is also recognised that young people can achieve Level 2 GCSE or equivalent mathematics and science qualifications in post-16 education. Data on such Level 2 achievements are provided in the Royal Academy of Engineering FE STEM Data reports (2010 and 2011)[14]. However, this research is primarily focussed on mathematics and sciences, the subjects required for progression in SET roles, and examines whether the education system in England is providing sufficient opportunity for all young people to progress in these areas.

4. Mathematics and Science Qualification Combinations

There is a hierarchy of qualification combinations in science and mathematics that can be achieved at the end of Key Stage 4. In descending order, these combinations of achievements show the potential for progression to A level or equivalent qualifications. These can be seen in Table 1 and graded 1 (highest) to 8 (lowest) in terms of potential for progression. The data in this report is presented in this report is based on these combinations[15].

The first three rows present those qualification combinations considered to be the minimum level of qualifications for progression to further study and a career in Science, Engineering and Technology roles without the need for remedial study at this level of qualification. The rest show various levels of attainment in mathematics or science qualifications. Pupils achieving A*–C grade in mathematics GCSE would be able to progress to further study but would likely need to revisit aspects of science at this level to progress in science, engineering and technology roles. Pupils who did not achieve A*–C in mathematics at GCSE would require remedial study in mathematics to progress.

9 Attainment by age 19, including by Local Authority and age, can be found in DfE (April 2012): Level 2 and 3 Attainment by Young People in England Measured Using Matched Administrative Data: Attainment by Age 19 in 2011 http://www.education.gov.uk/rsgateway/DB/SFR/s001059/index.shtml

10 Maths and science education: the supply of high achievers at A level. Research report 079. Department for Education www.education.gov.uk

11 There may be circumstances when one Level 2 science qualification may be sufficient to gain entry to a range of engineering and technology Advanced Apprenticeships which will have subsequent progression opportunities.

12 It is, of course possible for any person to re-visit science and mathematics qualifications during post-16 education. However, this report is examining specifically the potential supply of a future workforce in science, engineering and technology roles at end of key stage 4.

13 See the discussion of progression (Annex p.40) in the RAEng (2011) FE and Skills STEM Data report July 2011 – http://www.thedataservice.org.uk/statistics/other_statistics_and_research/

14 RAEng FE and Skills STEM Data Project (2010 and 2011) http://www.thedataservice.org.uk/statistics/other_statistics_and_research/

15 In the data analysis, these groups are exclusive, i.e. a pupil can only appear in one group.

TABLE 1: Hierarchy of combinations of science and mathematics qualifications for potential to progress to level 3 qualifications in Science, Engineering and Technology

Combination of qualifications	Ability to progress
Achieved A*–C Grade at GCSE in Triple Science[16] GCSEs (individual Physics, Chemistry and Biology GCSEs) and A*–C grade in Mathematics GCSE.	1 (Highest)
Achieved A*–C grade in Double science (Core-science GCSE and Additional-science GCSE or Applied-science GCSE) and A*–C grade 2 in Mathematics GCSE.	2
Achieved level 2 (equivalent to A*–C grade) in a vocational science or engineering qualification and A*–C grade in Mathematics GCSE.	3
Minimum level of qualifications for immediate progression to further study	
Achieved A*–C grade in one science GCSE and A*–C grade in Mathematics GCSE.	4
Achieved A*–C grade in Mathematics GCSE but did not achieve a A*–C grade in science GCSE or equivalent qualification at level 2.	5
Achieved A*–C grade in two or more science GCSEs but did not achieve A*–C grade in Mathematics GCSE.	6
A*-G in one science GCSE and no A*–C grade in Mathematics GCSE	7
No entry for any science qualification and No A*–C grade in mathematics	8

5. Results of the analysis of the National Pupil Database

The analysis is presented in three sections. The first provides a quick glance at the general number of qualifications for all subjects entered for and attained at the end of Key Stage 4 across schools in England in 2010. There is then a more detailed examination of participation and attainment in science and mathematics qualifications for the same year. Next, the variation in participation and attainment in science and mathematics across different sub-regions and Local Authorities of England is shown. Finally, there is a comparison of participation in Triple Science in state maintained schools and schools in the independent sector.

6. Participation and attainment in all subjects at Key Stage 4

In total there were 651,000 pupils in the cohort at the end of key stage 4. However, not all entries or achievements are valid in terms of national reporting or statistical analysis. Applying DfE filters to the data while adopting an inclusive approach[17] means this report covers 633,500 pupils as the cohort for key stage 4 in 2009/10 (applying a rounding to the nearest 500 pupils).

Table 2 shows a general picture of participation and attainment in examinations across all subjects in 2009/10. Pupils were entered on average for 10 GCSE and equivalent qualifications across all subjects[18]. However, if the number of qualifications excludes vocational qualifications and only considers GCSEs, the average number of qualifications entered by pupils falls to 7 GCSEs.

On average, pupils achieved 5 GCSEs at A*–C and 2 equivalent vocational qualifications at level 2 across all subjects.

TABLE 2: Analysis of total numbers of entries and achievements (per student) at the end of key stage 4, 2009/10

	Total number of GCSE and equivalent entries (per student)	Total number of GCSE/GNVQ entries (without equivalents)	Total number of level 2 GCSE and equivalent qualifications achieved	Total number of level 2 GCSE grades A*–C
Mean	10.6	7.7	7.7	5.4
Median	11	8.5	8.8	6
Maximum	27.5	17.5	25	16

16 Triple science also includes a small proportion (less than 1%) of pupils who were entered for physics GCSE and another science but not as Triple Science .

17 We include all pupils at the end of Key Stage 4 on the role of educational institution including state and independent schools, pupil referral units, special educational needs schools and hospital schools.

18 The figures are rounded down to the lowest whole number from the data in Table 2.

TABLE 3: Participation and attainment of pupils in science and mathematics subjects at Key Stage 4 in schools across England in 2009/10

			Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Science subjects and qualification groups	Number of pupils entered	% of total cohort	A*–C in 3 Sciences and Maths A*–C	A*–C in 2 Sciences and Maths A*–C	Level 2 (equiv to A*–C) in vocational science or engineering and Maths A*–C	A*–C in 1 Science and Maths A*–C	Maths A*–C but no Sciences at A*–C	A*–C in 2 or 3 Sciences but no Maths A*–C	A*–C in 1 Science but no Maths A*–C	No science qualification taken and no Maths A*–C and
Entered Triple Science GCSE	112,500	18%	101,500 16%	6,500 1%		1,500	1,500		2,000	
Entered Double Science GCSEs	341,500	54%		185,000 29%		30,000 5%	20,500 3%	20,500 3%	85,000 13%	
Entered BTEC or OCR Science or BTEC Engineering equivalent to 2 or more GCSEs	62,500	10%			23,500 4%			39,000 6%		
Entered 1 Science GCSEs or equivalent qualification	67,000	10%				12,000 2%	6,500 1%		49,000 8%	
Entered no Science GCSEs or equivalent qualifications	50,000	8%					6,000 1%			44,000 7%
Total Cohort	633,500		101,500	191,500	23,500	43,000	35,000	67,000	136,000	44,000
% of cohort			16%	30%	4%	7%	5%	11%	21%	7%

6.1 Participation and Attainment in Science and Mathematics

This section details the numbers of pupils being entered for the various combinations of science and mathematics qualifications and their attainment in those subjects. Table 3 presents data on both participation and attainment.

6.1.1 Participation

Figure 1 presents the proportion of pupils entered for science qualifications. The analysis shows that in 2010, the majority of the cohort at 54% (341,500 pupils) was entered for Double Science GCSEs, a combination of a Core Science GCSE and an Additional Science GCSE or an Applied Science GCSE. Fewer than one in five pupils, at 18% of the cohort (112,500 pupils) were entered for Triple Science GCSEs (individual Physics, Chemistry and Biology GCSEs). One in ten pupils was entered for a vocational science qualification[19].

In total, 82% of pupils were entered for at least two sciences and mathematics qualifications. By implication almost one in five pupils was not even participating in the necessary qualifications for immediate progression to career in science, engineering and technology. Furthermore, one in twelve pupils was **not even entered for any** science GCSEs or equivalent qualification (Table 3).

6.1.2 Attainment

Figure 2 shows the proportion of pupils achieving different subject combinations across science and mathematics. Half of the cohort (over 300,000 pupils) achieved sufficient mathematics and science qualifications at A*–C grade at GCSE or Level 2 in equivalent vocational qualifications.

Of those pupils who were entered for Triple Science, the vast majority achieved A*–C grade in all three science subjects and A*–C grade in mathematics. They make up 16% of the total cohort (101,500 pupils).

19 For this study we have considered participation in BTEC First Certificates and Diplomas in Engineering as equivalent to participation in BTEC First Certificates and Diplomas and OCR Nationals in Applied Science for progression in engineering.

FIGURE 1: Participation in science qualifications at key stage 4 in England in 2010

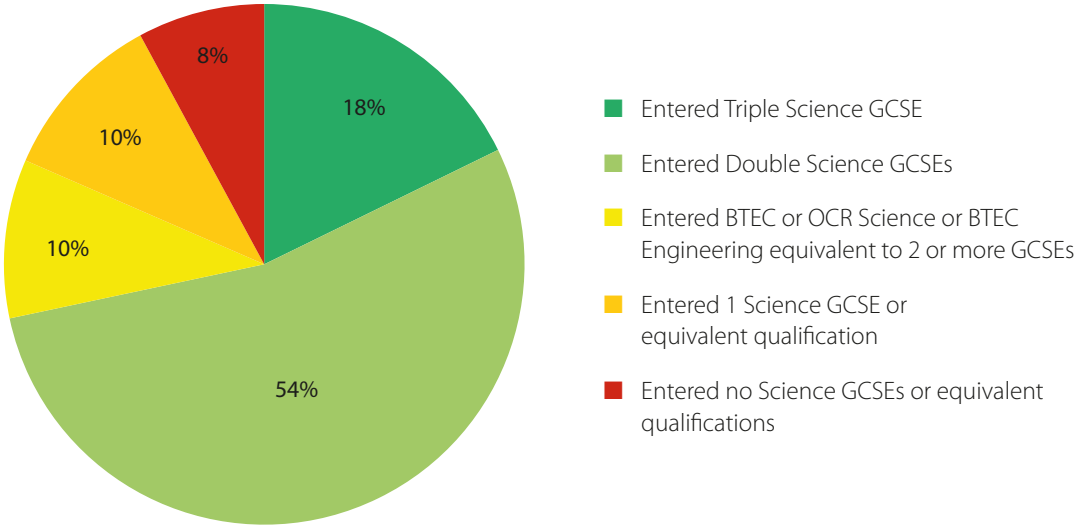
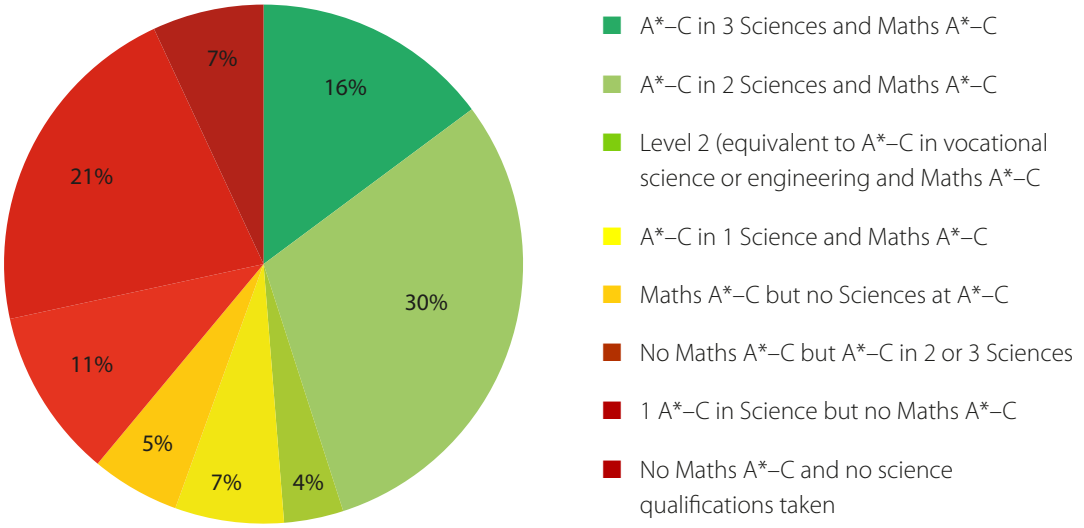


FIGURE 2: Attainment in combinations of science and mathematics qualifications at key stage 4 in England in 2010.



The pupils entered for Double Science, at 54% made up the bulk of the participants and of these, 29% of the cohort (185,000) achieved A*–C grade in Double Science and A*–C grade in mathematics GCSEs.

Table 3 also shows participation and attainment in vocational science subjects. In total, 62,500 pupils were entered for vocational science qualifications at the end of key stage 4. This was around 10% of the total cohort. However, over 60% of pupils entered for these qualifications did not achieve A*–C grade in mathematics GCSE. Another concern is that approximately 10% of the cohort (60,000 pupils) were able to achieve A*–C grades in 2 or 3 sciences but not in mathematics.

It is deeply worrying that 39% of the cohort (247,000 pupils) did not achieve A*–C in Mathematics GCSE, as was also highlighted by Prof Alison Wolf in her review of vocational education[20]. These pupils would be unlikely to progress towards level 3 qualifications in STEM or indeed any high-skilled employment without undertaking remedial work to achieve the necessary grades in mathematics.

The poorest performing group were the 50,000 pupils not entered for any science qualification. Almost 90% of them also failed to achieve A*–C grade in mathematics at GCSE.

20 DfE (2011). Review of Vocational Education – The Wolf Report – https://www.education.gov.uk/publications/standard/publicationDetail/Page1/DFE-00031-2011

Regional Analysis

This section examines how participation and attainment varies across the regions of England. The data is examined on two levels, first by 41 sub-divisions or sub-regions and also a more detailed view using the 152 Local Authorities as provided in the National Pupil Database.

Within the dataset, all school types, including independent schools, selective maintained and academies are included in the analysis to provide a true picture of local participation and attainment in science across England.

There will be movement of pupils across sub-regional and Local Authority borders and specialist, independent and selective provision will also have an impact on provision and attainment at a local level. Localised sector-specific business priorities may also have an effect on education and attainment for specific subjects in some regions. Furthermore, sharp demographic decline[21] in this age group will have a different impact by locality. For example, rural areas may have seen substantial reduction in pupil numbers compared with regions with large urban populations.

However, taking all this into account, at a sub-regional level the data shows significant variation in entry and attainment in science and mathematics GCSEs that might be seen as fundamental to obstructing progression for young people towards careers in science, engineering and technology roles. These results are now presented.

7.1 Participation in science qualifications at end of key stage 4 across sub-regions of England

Figure 3 shows the participation in two or more science qualifications (including vocational qualifications equivalent to 2 GCSEs) at key stage 4 across the 41 sub-regions of England. The regions are divided into quintiles with the lowest participating regions in red and the highest participating regions in dark green.

It can be seen from Figure 3 that there is a strong tendency towards increased participation in science in southern sub-regions of England, particularly towards the South West. Four of the five sub-regions with the highest participation in science were from this area.

Table 4 lists the 41 sub-regions of England in descending order based on the cumulative total of pupils entered for Triple Science, Double Science and vocational qualifications equivalent to two GCSEs. The table also shows the entries for Triple Science, Double Science, equivalent vocational qualifications, entry to only a single science GCSE and also the proportion of pupils who were not entered for any science qualification. Figures presenting the regional analysis of participation for these additional measures can be found in annex A.

The rows highlighted in green show the 5 sub-regions with the highest proportion of pupils entered for triple science, while the rows highlighted in red show the sub-regions with highest proportion of pupils **not entered** for any science qualification.

It is clear that there is considerable disparity in the participation across sub-regions in England, with the sub-region with the highest participation in science (Cornwall and the Isles of Scilly) some 22% more than the lowest participating sub region (Lincolnshire and Rutland). The national average for participation in a minimum of two science subjects at the end of key stage 4 was 82%. The wide variation in participation is significant because each sub-region will have substantial numbers of pupils. Given this large sample size, significant variations from the national average should not be expected.

The South West also features prominently in the sub-regions with the highest participation in triple science. Bournemouth, Dorset and Poole had the highest proportion of entries to triple science with just under 28% of the cohort. This contrasts with North and North East Lincolnshire which had just 11.7% of pupils entering triple science.

North and North East Lincolnshire however is positioned mid-table cumulatively because of a very high proportion (34.6%) of students participating in vocational science and engineering qualifications. The national average for entry to vocational science qualifications was 10%. There are similar occurrences with Nottinghamshire which has 27.3% participation in vocational sciences and Staffordshire and Stoke which has high vocational science participation (18.7%) but some of the lowest participation in triple science.

The rows highlighted in red show the sub-regions with highest proportion of pupils **not entered** for any science qualification. In Lincolnshire and Rutland, this accounted for one in five pupils. Even in regions where there is substantial manufacturing eg Merseyside and Birmingham and Solihull in the West Midlands there were also many pupils not participating in any science qualifications.

21 See, for example, Chart 2 in JCQ (2011) – Number of 16 year olds per year (UK) Entry Trends for GCSE, Applied GCSE and Entry Level Certificate Results Summer 2011 – http://www.jcq.org.uk/national_results/news_releases/2011/

FIGURE 3: Proportion of pupils entered for at least 2 science qualifications at key stage 4 across the 41 sub-regions of England in 2010.

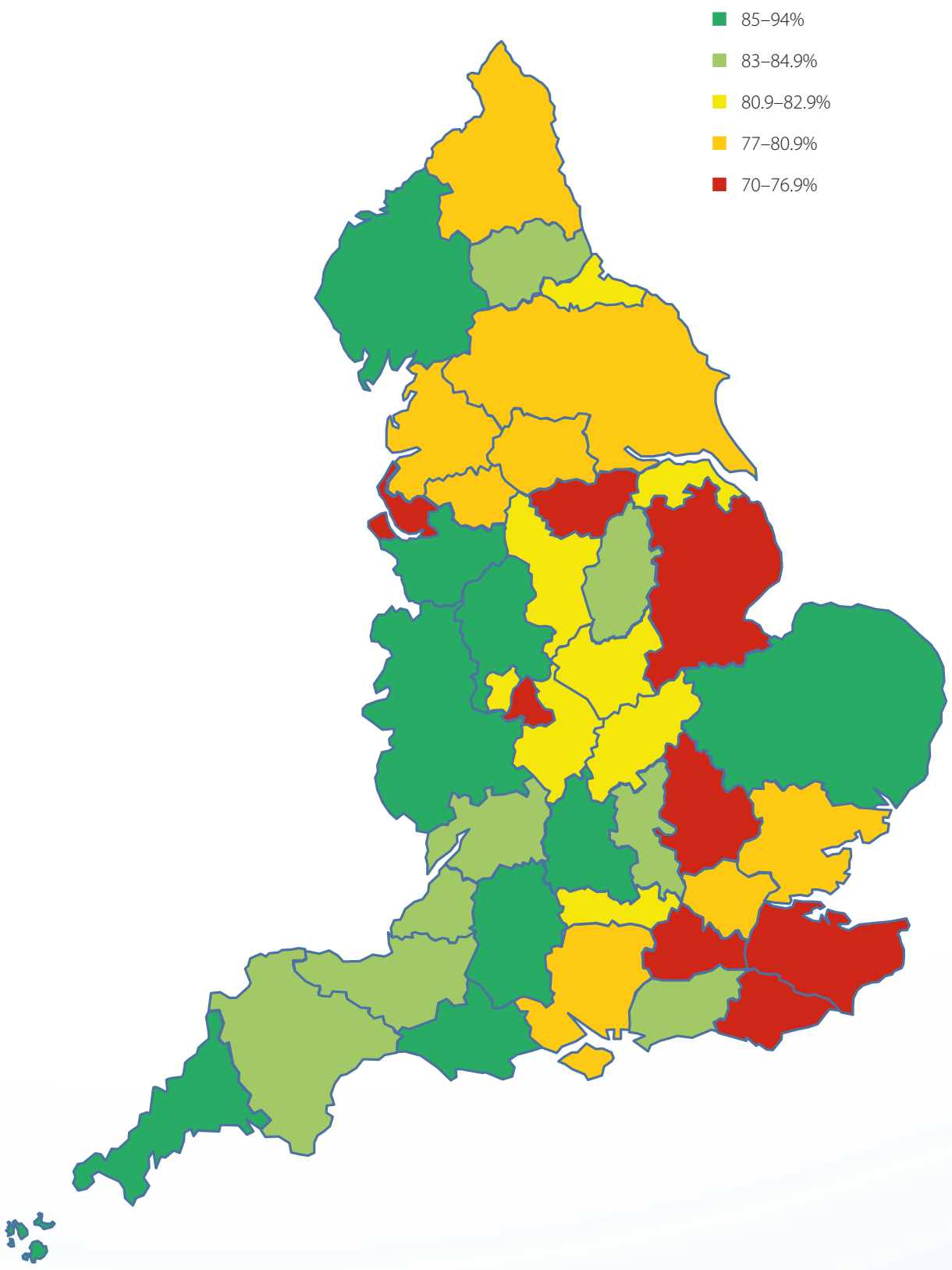


TABLE 4: Participation in sciences across the 41 sub-regions of England (rows highlighted in green have highest participation in triple science, red – lowest participation in any science qualification).

Sub region	Cumulative entry to 2 or more Science qualifications	Entered Triple Science GCSEs	Entered Double Science GCSEs	Entered vocational science or engineering eqiv to 2 or more GCSEs	Entered one Science GCSEs or equivalent qualification	Entered no Science qualification
Cornwall and Isles of Scilly	93.30%	21.80%	69.80%	1.70%	4.20%	2.60%
Cheshire	89.00%	21.10%	57.80%	10.10%	6.90%	4.10%
Bournemouth Dorset Poole	88.00%	27.70%	59.90%	0.40%	7.30%	4.70%
Swindon and Wiltshire	86.30%	18.40%	57.80%	10.10%	6.00%	7.70%
Oxfordshire	85.90%	23.20%	58.40%	4.40%	6.00%	8.10%
Cumbria	85.50%	23.90%	55.30%	6.40%	7.80%	6.60%
Herefordshire Worcestershire Shropshire Telford & Wrekin	85.50%	16.50%	55.90%	13.10%	8.30%	6.20%
Peterborough Cambridgeshire Norfolk and Suffolk	85.30%	20.90%	56.30%	8.10%	8.20%	6.50%
Staffordshire and Stoke	85.10%	13.60%	52.80%	18.70%	8.90%	6.00%
Durham	84.80%	12.70%	57.40%	14.70%	8.30%	6.90%
West Sussex	84.70%	19.00%	61.60%	4.10%	10.50%	4.80%
Devon Plymouth Torbay	84.70%	14.40%	50.40%	19.80%	10.80%	4.60%
Somerset	84.20%	20.20%	59.70%	4.40%	9.60%	6.20%
West of England	84.10%	20.60%	56.00%	7.50%	9.60%	6.20%
Nottinghamshire	84.00%	16.60%	40.20%	27.30%	7.40%	8.50%
Buckinghamshire	83.30%	22.80%	53.30%	7.10%	11.70%	5.10%
Gloucestershire	83.00%	22.80%	55.40%	4.80%	10.20%	6.80%
Derbyshire	82.80%	15.40%	54.90%	12.50%	9.90%	7.20%
Leicestershire	82.60%	13.30%	64.50%	4.80%	10.60%	6.80%
Coventry and Warwickshire	82.30%	16.40%	53.30%	12.60%	11.40%	6.20%
Berkshire	82.30%	20.40%	54.30%	7.50%	8.50%	9.30%
Black Country	82.20%	12.20%	55.30%	14.70%	10.50%	7.20%
N and NE Lincolnshire	82.20%	11.70%	35.90%	34.60%	9.50%	8.40%
Tees Valley	81.40%	13.70%	61.70%	5.90%	10.30%	8.30%
Northamptonshire	81.00%	18.20%	57.10%	5.70%	11.30%	7.60%
Tyne Wear and Northumberland	80.60%	16.50%	56.30%	7.80%	8.80%	10.60%
North and East Yorkshire	80.50%	15.80%	55.40%	9.30%	11.30%	8.20%
Essex Southend-on-Sea and Thurrock	80.30%	14.90%	54.20%	11.20%	12.40%	7.30%
Greater Manchester	80.20%	15.30%	51.20%	13.70%	11.50%	8.40%
Hampshire and Isle of Wight	79.20%	18.70%	56.10%	4.40%	11.90%	9.00%
Lancashire	78.10%	15.80%	50.20%	12.10%	14.00%	7.90%
West Yorkshire	77.70%	15.00%	55.80%	6.90%	12.90%	9.40%
London	77.50%	17.30%	49.80%	10.40%	11.30%	11.30%
East Sussex	76.90%	16.80%	52.80%	7.30%	15.60%	7.50%
Surrey	76.40%	19.90%	52.90%	3.60%	10.50%	13.10%
South Yorkshire	76.30%	14.20%	51.50%	10.60%	15.80%	7.90%
Bedford Borough Central Bedfordshire Hertfordshire & Luton	76.30%	20.10%	52.10%	4.10%	13.60%	10.10%
Birmingham and Solihull	76.20%	19.40%	39.50%	17.30%	11.90%	11.90%
Merseyside	73.60%	14.50%	37.90%	21.20%	8.90%	17.50%
Kent and Medway	71.80%	17.30%	47.60%	6.90%	20.10%	8.10%
Lincolnshire and Rutland	71.20%	13.90%	50.00%	7.30%	6.10%	22.70%

7.2 Participation in science qualifications at end of key stage 4 across Local Authorities of England

While the broad analysis of participation by sub-regions shows considerable variation, it masks even greater disparity when examining at more fine detail at Local Authority level. We use local authorities as a useful narrower geographical boundary descriptor, but with the growth in the Academies and Free Schools programme there is no longer a simple link between accountability of schools within a Local Authority boundary and the Local Authority itself.

Figure 4 shows the participation in two or more science qualifications (including vocational qualifications) by Local Authority. The Local Authorities are divided into quintiles with the lowest participation in red and the highest participation in dark green. Further figures on participation by Local Authority can be found in annex A.

Table 5a shows the ten Local Authorities[22] with the highest proportion of pupils entered for two or more science GCSEs and Table 5b shows the ten Local Authorities with the lowest proportion of pupils entered for two or more science GCSEs.

The total dataset reveals that 88 out of 152 Local Authorities have a smaller proportion of pupils being entered for Triple Science compared with the national average of 17.8%.

When examining participation in sciences by Local Authority, it becomes apparent that the *Science South* effect is less strong. Individual excellence is present all over England. Trafford in the North West has the highest participation in science qualifications and Northumberland, York, South Tyneside and Warrington also feature in the top ten Local Authorities for participation.

Trafford achieves its position at the top of the table of Local Authorities because of the very high proportion of pupils being entered for vocational science subjects. Similarly South Tyneside has the tenth lowest participation in triple science of any Local Authority but has the highest participation in Core and Additional Science GCSEs in England. Poole is the only Local Authority in the top ten, which also features in the top ten for Triple Science.

TABLE 5A: The ten Local Authorities with the highest proportion of pupils entered for science qualifications at the end of Key Stage 4 (rows highlighted in green are in the top 10 for highest participation in triple science).

Local Authority	Cumulative entry to 2 or more Science qualifications	Entered Triple Science	Entered Double Science	Entered vocational science or engineering eqiv to 2 or more GCSEs	Entered one Science GCSE or equivalent qual	Entered no Science GCSEs or equivalent quals
Trafford	93.30%	20.10%	52.90%	20.30%	4.70%	2.00%
Poole	93.20%	36.70%	56.50%	0.00%	4.90%	2.00%
Northumberland	90.90%	25.00%	52.80%	13.10%	4.70%	4.40%
Swindon	90.30%	16.80%	57.90%	15.60%	2.20%	7.50%
Wokingham	90.10%	24.10%	60.90%	5.10%	6.90%	3.00%
Suffolk	90.10%	18.30%	64.30%	7.50%	6.10%	3.80%
Central Bedfordshire	90.00%	20.40%	57.60%	12.00%	6.60%	3.40%
York	89.30%	16.80%	65.00%	7.50%	5.70%	5.00%
South Tyneside	89.30%	9.70%	73.20%	6.40%	6.50%	4.20%
Warrington	89.20%	21.80%	54.80%	12.60%	5.10%	5.80%

22 Note that the Isles of Scilly and City of London were first and second on the table but have been removed because the population size in these local authorities is very small and is giving an unrepresentative skew to the data. They are however included in the maps.

FIGURE 4: Proportion of pupils entered for at least 2 science qualifications at key stage 4 across the 152 Local Authorities in England in 2010. The Boroughs of Greater London are shown inset.

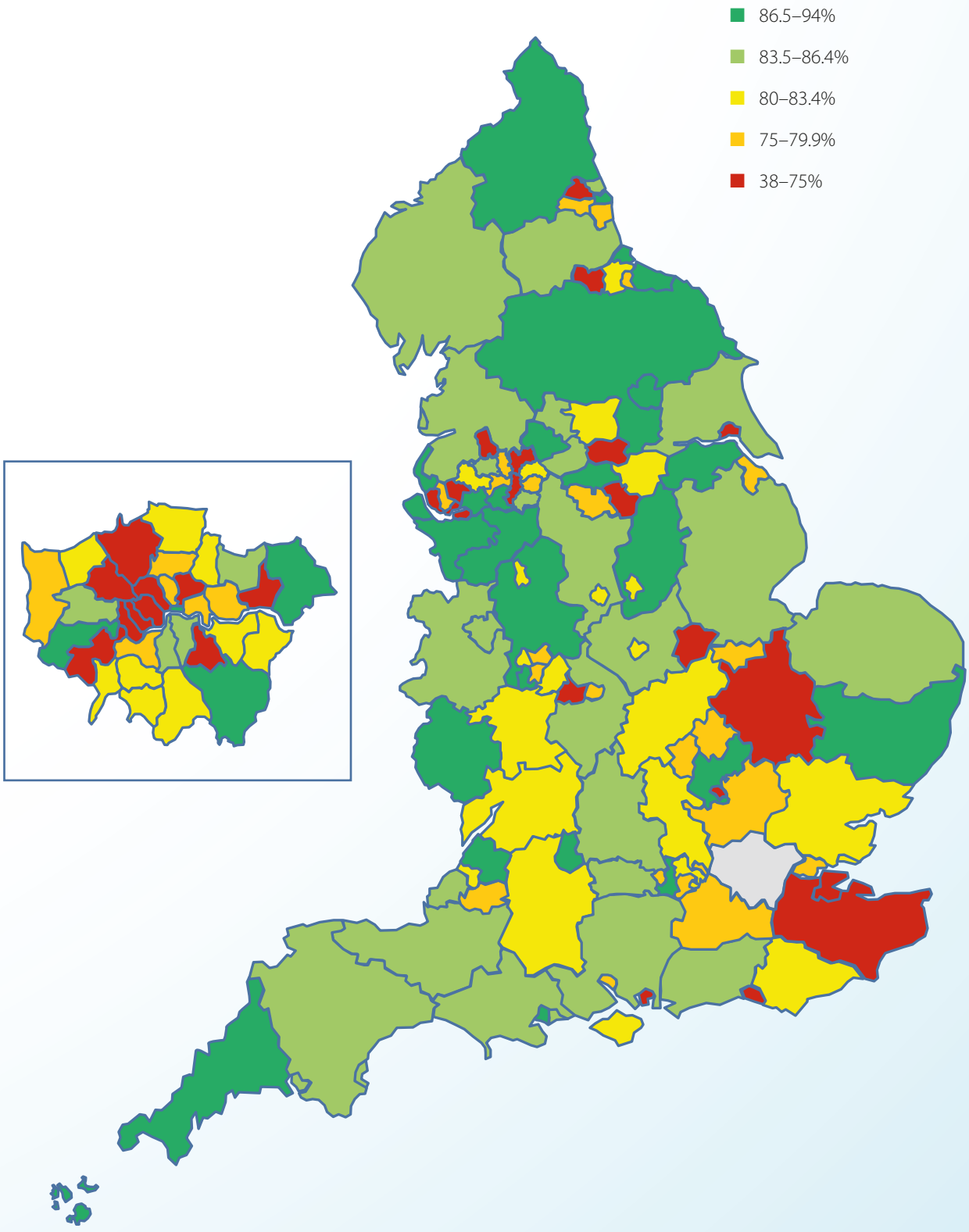


TABLE 5B: The ten Local Authorities with the lowest proportion of pupils entered for two science qualifications at the end of Key Stage 4 (rows highlighted in red are in the bottom 10 for participation in any science qualification)

Local Authority	Cumulative entry to 2 or more Science qualifications	Entered Triple Science	Entered Double Science	Entered vocational science or engineering eqiv to 2 or more GCSEs	Entered one Science GCSE or equivalent qual	Entered no Science GCSEs or equivalent quals
Newcastle upon Tyne	67.6%	18.7%	40.6%	8.3%	10.2%	22.2%
Liverpool	67.6%	15.7%	33.6%	18.3%	12.5%	20.0%
Rochdale	65.4%	7.9%	51.3%	6.2%	23.7%	10.9%
Blackburn with Darwen	65.2%	11.1%	46.3%	7.8%	25.1%	9.7%
Kensington and Chelsea	64.9%	14.1%	41.3%	9.6%	9.0%	26.1%
Westminster	63.8%	11.6%	46.2%	6.0%	24.2%	12.0%
Hackney	63.7%	13.5%	43.6%	6.7%	16.1%	20.1%
Kingston upon Hull	59.8%	8.5%	27.9%	23.3%	19.6%	20.7%
Rutland	57.8%	10.8%	47.0%	0.0%	2.2%	40.0%
Halton	54.2%	13.6%	34.7%	6.0%	16.5%	29.3%

Local Authorities in Merseyside, the North West and London feature prominently in the table of lowest participation in science qualifications. In Rutland, 40% of pupils were not entered for any science qualifications. Newcastle upon Tyne had a higher proportion of pupils entering for triple science compared with the national average, but also had around a third of students taking just one or even no science qualifications at all. As is evident from the table, the majority of Local Authorities with the lowest number of entries for at least two science qualifications also have the lowest proportion of pupils being entered for any science qualification.

While the broad analysis of participation by sub-regions and by Local Authorities both show substantial variation, what is perhaps most interesting is the significant disparity that is found within regions and across neighbouring Local Authorities. As noted earlier, a variety of local factors may contribute to this picture.

The local differences are highlighted in the data for London (Table 6)[23]. Across London, the difference of entry to Triple Science ranged by 34% across the boroughs.

The data for London also shows some curious results. The borough of Havering shows the highest participation for two or more science qualifications yet has very low participation in triple science. While Sutton, which has the highest proportion of pupils participating in triple science in England, also has a surprisingly high number of pupils – almost one in five – doing very little science.

Boroughs which have low participation in Triple Science such as Islington, Newham and Waltham Forest have substantial proportions of pupils being entered for Double Science GCSEs. And other boroughs, such as Croydon have a significant proportion of their cohorts participating in vocational science and engineering qualifications.

Interestingly, the affluent boroughs of Hammersmith and Fulham, Kensington and Chelsea and Richmond upon Thames all have low participation in science qualifications at key stage 4. In Richmond almost one in five pupils are not entered for any science qualifications. In Kensington and Chelsea it is one in four pupils.

7.3 Attainment in science and mathematics qualifications at end of key stage 4 by sub-regions of England

Figure 5 shows the regional variation of attainment in two or more science qualifications and maths GCSE at grades A*–C. The regions are divided into quintiles with the lowest participating regions in red and the highest participating regions in dark green.

23 Particular issues affecting the disparity in participation and attainment in London Boroughs include ease of movement of pupils to schools across Local Authority boundaries and very large income distribution. More information can be found at www.londonpovertyprofile.org.uk/test/

TABLE 6: Variation in participation in science qualifications the Boroughs of Greater London (rows highlighted in green have highest participation in triple science, rows highlighted in red are in the bottom 10 for participation in any science qualification)

Local Authority	Cumulative entry to 2 or more Science qualifications	Entered Triple Science	Entered Double Science	Entered vocational science or engineering eqiv to 2 or more GCSEs	Entered one Science GCSE or equivalent qualification	Entered no Science GCSEs or equivalent qualifications
Havering	87.40%	12.40%	66.10%	8.90%	7.10%	5.50%
Hounslow	86.60%	13.40%	61.10%	12.10%	6.70%	6.70%
Brent	86.30%	18.00%	59.90%	8.40%	9.50%	4.20%
Ealing	85.90%	16.50%	60.50%	8.80%	6.80%	7.30%
Southwark	84.60%	21.40%	46.80%	16.40%	9.80%	5.60%
Redbridge	84.40%	21.90%	58.20%	4.30%	11.20%	4.30%
Barnet	83.80%	14.10%	59.30%	10.40%	6.40%	9.80%
Lambeth	83.60%	16.60%	50.80%	16.20%	9.10%	7.30%
Croydon	83.30%	15.40%	41.50%	26.40%	6.80%	9.90%
Waltham Forest	83.20%	8.30%	69.40%	5.50%	11.80%	5.00%
Sutton	81.70%	39.10%	31.90%	10.70%	10.90%	7.40%
Harrow	81.70%	20.80%	51.60%	9.30%	8.30%	10.00%
Bromley	81.60%	18.10%	52.40%	11.20%	13.10%	5.20%
Enfield	81.40%	10.10%	56.20%	15.10%	14.50%	4.10%
Greenwich	80.80%	15.60%	59.60%	5.60%	10.60%	8.60%
Kingston upon Thames	80.70%	23.90%	48.50%	8.30%	9.50%	9.80%
Merton	80.00%	21.80%	39.50%	18.70%	6.30%	13.70%
Wandsworth	79.70%	27.50%	42.60%	9.60%	9.40%	10.90%
Tower Hamlets	79.00%	15.40%	56.80%	6.80%	13.30%	7.70%
Islington	79.00%	5.00%	63.30%	10.60%	13.40%	7.60%
Hillingdon	77.50%	15.60%	47.00%	14.90%	14.60%	7.90%
Haringey	77.40%	19.50%	43.90%	14.00%	8.40%	14.20%
Newham	77.10%	6.40%	64.30%	6.40%	15.70%	7.20%
Bexley	76.00%	19.70%	43.20%	13.10%	19.50%	4.50%
Camden	74.80%	14.30%	55.50%	5.00%	13.00%	12.20%
Lewisham	73.70%	19.10%	50.90%	3.70%	15.00%	11.30%
Richmond upon Thames	73.00%	16.40%	49.20%	7.50%	8.00%	19.00%
Barking and Dagenham	70.40%	12.00%	44.20%	14.30%	20.40%	9.20%
Hammersmith and Fulham	70.30%	17.20%	35.30%	17.80%	12.50%	17.20%
Kensington and Chelsea	64.90%	14.10%	41.30%	9.60%	9.00%	26.10%
Westminster	63.80%	11.60%	46.20%	6.00%	24.20%	12.00%
Hackney	63.70%	13.50%	43.60%	6.70%	16.10%	20.10%

FIGURE 5: Proportion of pupils who achieved A*–C grade in two science GCSEs (or equivalent vocational qualifications) and A*–C grade in mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

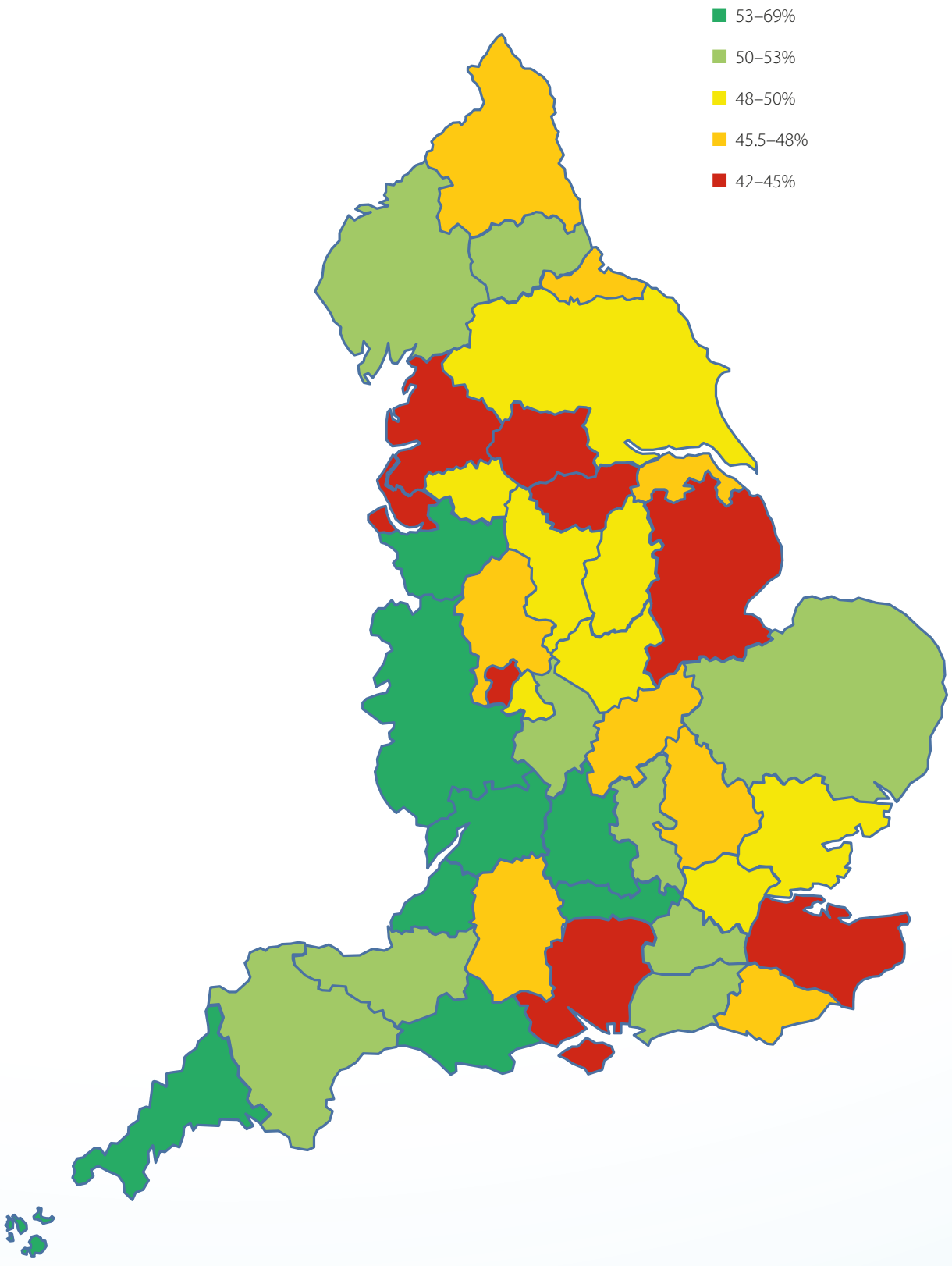


Table 7 shows attainment in combinations of science and mathematics qualifications as identified in Table 1. The sub-regions are ranked according to the cumulative proportion of pupils achieving A*–C grades in two or more science subjects (or equivalent attainment vocational subjects) and A*–C grade in mathematics GCSE. Further figures on regional variation of attainment by additional measures can be found in annex B.

The ten sub-regions highlighted in green are those with highest proportion of pupils attaining Triple Science GCSEs. The ten sub-regions highlighted in red have the lowest attainment in mathematics GCSEs.

Again, from the data it is apparent that the Science South effect is evident, where 8 of the top ten sub-regions for attainment are from the south of England and the majority in the South West. Bournemouth, Dorset and Poole have the highest proportion of pupils achieving triple science GCSEs and Mathematics GCSEs with A*–C grades.

The majority of sub-regions fall below the national average for attainment (48.5%) in two or more science qualifications and mathematics at grade A*–C in GCSEs. The pattern of low attainment repeats the pattern for low participation with regions such as South Yorkshire, Black Country, Lincolnshire and Merseyside featuring prominently.

Seven of the ten sub-regions with the lowest attainment in science also had the lowest attainment in mathematics. Lincolnshire and Rutland has the lowest attainment in mathematics GCSEs with 47% of pupils failing to achieve A*–C grade.

In some compensation North and North East Lincolnshire have the highest proportion of pupils, at 15%, achieving vocational science qualifications.

TABLE 7: Attainment in combinations of science and mathematics qualifications across the 41 sub-regions of England (rows highlighted in green are in the top 10 sub-regions for attainment in triple science and maths, rows highlighted in red are in the bottom 10 for attainment in maths)

Sub region	Cumulative achievement of 2 or more Science qualifications and maths	A*–C in 3 Sciences and Maths A*–C	A*–C in 2 Sciences and Maths A*–C	Level 2 (equiv to A*–C) in vocational science or engineering	A*–C in 1 Science and Maths A*–C	Maths A*–C but no Sciences at A*–C	A*–C in 2 or 3 Sciences but no maths A*–C	1 A*-G in Science but no Maths A*–C
Cornwall and Isles of Scilly	68.4%	20.9%	46.9%	0.5%	3.2%	7.4%	3.5%	17.5%
Cheshire	57.6%	19.4%	33.5%	4.6%	5.8%	3.8%	8.6%	24.3%
Gloucestershire	54.9%	21.0%	32.3%	1.7%	6.6%	3.5%	7.4%	27.6%
Herefordshire Worcestershire Shropshire Telford & Wrekin	54.5%	15.6%	33.9%	5.0%	5.7%	4.0%	12.1%	23.6%
Oxfordshire	53.8%	21.9%	31.0%	0.9%	5.5%	4.8%	9.4%	26.5%
Berkshire	53.7%	19.6%	32.0%	2.1%	5.8%	5.0%	8.5%	27.0%
Bournemouth Dorset Poole	53.7%	24.6%	28.9%	0.2%	5.9%	5.6%	3.6%	31.2%
West of England	53.2%	19.7%	30.4%	3.1%	5.7%	4.4%	8.8%	27.9%
Cumbria	52.8%	21.5%	29.2%	2.1%	5.6%	4.2%	7.9%	29.5%
Devon Plymouth Torbay	52.6%	13.5%	30.9%	8.2%	6.0%	3.8%	14.3%	23.2%
Surrey	52.4%	18.9%	32.5%	1.1%	6.9%	4.7%	6.6%	29.4%
Durham	52.3%	12.1%	34.6%	5.6%	4.3%	4.8%	13.5%	25.0%
Buckinghamshire	51.6%	22.1%	27.5%	2.1%	7.1%	6.6%	7.3%	27.4%
West Sussex	51.2%	17.5%	32.5%	1.3%	6.5%	4.5%	8.4%	29.3%
Peterborough Cambridgeshire Norfolk and Suffolk	50.3%	19.5%	28.4%	2.4%	6.1%	4.4%	9.5%	29.6%
Coventry and Warwickshire	50.2%	15.7%	29.5%	5.0%	7.5%	4.1%	11.7%	26.5%
Somerset	50.1%	19.0%	30.2%	0.9%	6.6%	6.0%	7.9%	29.3%
North and East Yorkshire	50.0%	14.7%	32.1%	3.3%	6.5%	4.9%	10.7%	27.9%
Nottinghamshire	49.1%	15.6%	23.3%	10.2%	4.8%	3.4%	18.6%	24.1%
Derbyshire	49.1%	13.8%	29.5%	5.9%	7.4%	6.1%	9.3%	28.1%
Birmingham and Solihull	49.0%	18.8%	23.6%	6.7%	6.5%	6.8%	12.5%	25.1%
Essex Southend-on-Sea and Thurrock	48.9%	14.2%	30.4%	4.3%	8.8%	6.9%	8.6%	26.8%
London	48.9%	16.3%	28.8%	3.8%	7.1%	6.0%	9.7%	28.3%
Greater Manchester	48.8%	14.3%	29.0%	5.5%	7.4%	5.5%	10.9%	27.4%
Leicestershire	48.0%	12.4%	33.8%	1.8%	5.7%	4.5%	8.1%	33.7%
Swindon and Wiltshire	47.8%	17.0%	27.1%	3.7%	5.8%	4.3%	10.6%	31.5%
Bedford Borough Central Bedfordshire Hertfordshire & Luton	47.5%	18.5%	27.6%	1.5%	9.0%	7.7%	6.0%	29.8%
NE and N Lincolnshire	47.5%	10.5%	21.6%	15.4%	7.8%	3.7%	21.1%	19.9%
Tyne Wear and Northumberland	47.4%	15.2%	29.0%	3.2%	5.2%	6.6%	9.0%	31.7%
East Sussex	46.7%	15.0%	29.0%	2.8%	8.3%	5.2%	8.8%	31.1%
Tees Valley	46.7%	12.7%	32.8%	1.2%	7.3%	5.3%	8.3%	32.4%
Northamptonshire	46.2%	16.3%	27.7%	2.2%	7.0%	5.0%	6.7%	35.1%
Staffordshire and Stoke	45.8%	11.7%	26.8%	7.4%	6.3%	4.8%	14.3%	28.8%
West Yorkshire	45.1%	13.8%	28.4%	2.9%	6.7%	6.6%	7.9%	33.7%
Merseyside	45.1%	13.3%	23.6%	8.2%	5.9%	6.6%	15.2%	27.2%
Hampshire and Isle of Wight	44.8%	17.8%	25.4%	1.6%	5.6%	7.1%	8.1%	34.4%
Lancashire	44.7%	14.4%	26.3%	4.0%	7.9%	5.1%	11.2%	31.1%
Lincolnshire and Rutland	44.5%	13.3%	28.3%	2.8%	5.6%	3.6%	6.6%	39.7%
Black Country	43.2%	11.3%	26.2%	5.6%	7.0%	6.0%	11.7%	32.1%
Kent and Medway	43.1%	15.6%	25.2%	2.3%	9.5%	8.3%	5.9%	33.2%

7.4 Attainment in science and mathematics qualifications at end of key stage 4 across Local Authorities of England

Figure 6 shows the variation of attainment in two or more science qualifications and maths GCSE at grades A*–C by Local Authorities across England. The Local Authorities are divided into quintiles with the lowest participating regions in red and the highest participating regions in dark green. Further figures on different measures of attainment across Local Authorities can be found in annex B.

Tables 8a and 8b show the performance of pupils in science and mathematics qualifications by Local Authority. In Table 8a the rows highlighted in green show the Local Authorities with the highest achievement in triple science GCSEs.

Trafford, which had the highest participation in sciences of any Local Authority also has the highest number of achievements. Wokingham and Warrington are the other two which also featured in the top ten Local Authorities for participation and are present in the table for highest achievements.

Interestingly, South Tyneside, Swindon and Central Bedfordshire, were all in the ten highest participating Local Authorities for science qualifications at key stage 4 but then all three fell below national average for attainment in at least two science qualifications and mathematics GCSEs.

Similar lack of correlation between participation and attainment is also found by comparing Sutton with Poole. The Borough of Sutton in London which had the highest participation in Triple Science also had the highest number of achievements in Triple Science. This was followed by Poole, for both participation and attainment. However, in Poole 35% of pupils failed to achieve A*–C in mathematics GCSE, whereas in Sutton fewer than a quarter of pupils failed to achieve A*–C in mathematics.

Three Local Authorities which had the lowest participation in science featured also in the table of lowest attainment. They are Rutland, Halton and Kingston upon Hull. Seven of the ten Local Authorities had the lowest attainment in mathematics; Manchester, Halton and Barking and Dagenham were the exception. Rutland had the poorest performance in mathematics, with 57.8% of the pupils failing to achieve grade A*–C in mathematics GCSE.

TABLE 8A: The ten Local Authorities with the highest proportion of pupils achieving combinations of science and mathematics qualifications at the end of Key Stage 4 (rows highlighted in green are in the top 10 Local Authorities for attainment in triple science and maths)

Local Authority	Cumulative achievement of 2 or more Science qualifications and maths	A*–C in Triple Science and Maths	A*–C in 2 Sciences and Maths	A*–C BTEC, OCR science equiv to 2+ GCSE and Maths	A*–C in 1 Science and Maths	A*–C In Maths but D–G Sciences	A*–C in 2 Sciences but No Maths	max of A*-G in 1 Science and No Maths
Trafford	67%	20%	38%	8%	6%	2%	14%	12%
Sutton	63%	38%	21%	4%	8%	5%	8%	16%
Wokingham	62%	23%	38%	1%	6%	4%	7%	20%
Cheshire East	61%	19%	36%	6%	6%	3%	8%	22%
Buckinghamshire	61%	31%	29%	1%	6%	6%	3%	24%
Barnet	61%	13%	44%	3%	6%	6%	9%	18%
Bath and North East Somerset	60%	27%	32%	1%	5%	4%	10%	22%
Redbridge	60%	21%	37%	2%	10%	6%	4%	20%
Warrington	59%	21%	32%	6%	5%	3%	10%	23%
North Yorkshire	59%	19%	39%	1%	5%	5%	6%	25%

FIGURE 6: Proportion of pupils who attained A*–C grade in two science GCSEs (or equivalent vocational qualifications) and A*–C grade in mathematics GCSE at Key Stage 4 across the Local Authorities of England in 2010. The Boroughs of Greater London are shown inset.

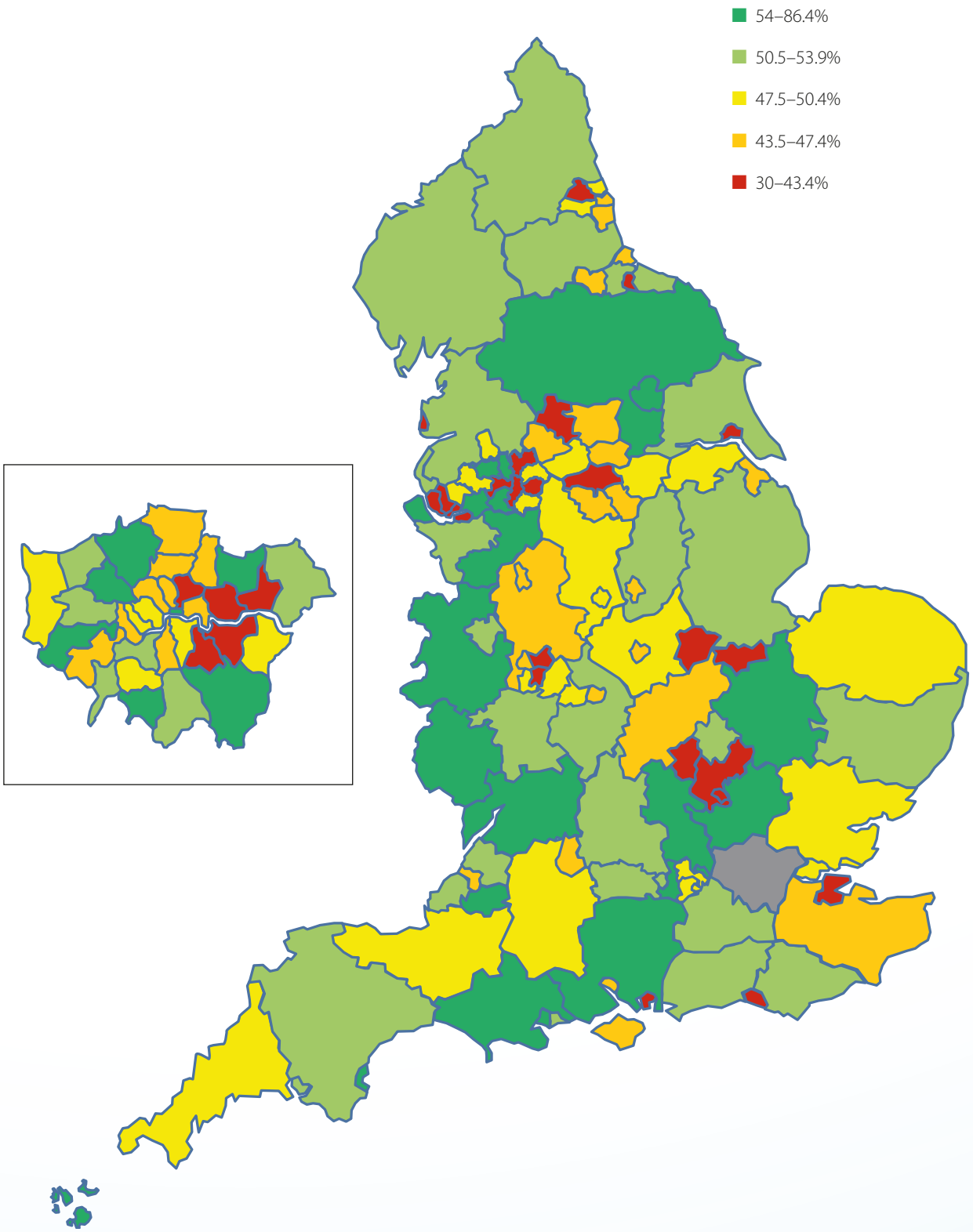


TABLE 8B: The ten local education authorities with the lowest proportion of pupils achieving combinations of science and mathematics qualifications at the end of Key Stage 4 (rows highlighted in red are in the bottom 10 Local Authorities for attainment in maths).

Local Authority	Cumulative achievement of 2 or more Science qualifications and maths	A*–C in Triple Science and Maths	A*–C in 2 Sciences and Maths	A*–C BTEC, OCR science equiv to 2+ GCSE and Maths	A*–C in 1 Science and Maths	A*–C In Maths but D-G Sciences	A*–C in 2 Sciences but No Maths	max of A*-G in 1 Science and No Maths
Sandwell	39%	7%	22%	10%	5%	6%	18%	33%
Manchester	39%	11%	21%	7%	7%	8%	12%	35%
Halton	38%	12%	22%	4%	9%	12%	3%	39%
Barking and Dagenham	38%	11%	22%	5%	10%	7%	12%	33%
Rutland	36%	11%	25%	0%	4%	2%	2%	56%
Knowsley	36%	3%	16%	17%	5%	5%	28%	27%
Portsmouth	33%	11%	23%	0%	6%	8%	10%	42%
Kingston upon Hull	33%	6%	17%	9%	7%	6%	17%	37%
Barnsley	32%	9%	20%	3%	10%	5%	8%	46%
Blackpool	31%	10%	19%	2%	11%	6%	11%	41%

The poorest performing Local Authority in England for pupils achieving at least two science and mathematics qualifications is Blackpool with only 31% of pupils achieving what is considered to be the minimum for progression to further study or work in science, engineering or technology roles.

The purpose of this study is to highlight the importance of science and mathematics education in schools as a first step to ensure an adequate supply of people working in science, engineering and technology roles to meet the needs of industry and the wider business community. The data show there are many areas across the country where there is significant industrial presence, yet high proportions of pupils are not being given the opportunity to achieve their full potential in sciences by being offered triple science qualifications and too few are achieving the minimum requirements for progression in science, engineering or technology.

Industry needs skilled people to perform its functions. Without these people, it cannot operate and this has an impact on the local economy. This is a local issue as much as an issue for the national economy. Local politicians, local businesses and schools must work together to improve the situation.

Businesses are making ever greater efforts to work closer with schools and this is very welcome. It is recommended however that role models and ambassadors should take the opportunity to explain to young people how high attainment in science and mathematics will enhance their career prospects and earning potential. Schools also have a duty to seek out business support. Young people are engaged and motivated when they see how science and mathematics are applied in real life.

Local politicians, particularly MPs must act as the catalyst for change. They need to act as local champions for increasing the knowledge and skills of young people in science, engineering and technology. They must work closely with local schools and local industry to improve provision and participation, and where there are failures, they must hold schools to account.

8. Participation in Triple Science by school type

The dataset allows comparison between state maintained schools and independent schools. (In the 2009/10 cohort, 7.5% (47,500 pupils) attended schools in the independent sector.) It also reveals participation rate differences between mixed sex and single-sex schools and the impact of school size on participation in Triple Science.

8.1 Entry to Triple Science by school type

The data in Table 9 shows the number of mixed-sex and single-sex schools for girls and boys in England. The table also shows the proportion of these schools which enter their pupils for Triple Science GCSEs.

TABLE 9: Proportion of pupils entered for Physics GCSE by end of Key Stage 4 by type of school and gender of school for England 2009/10

School type	Gender of School	Number of schools	Percentage of schools entering pupils for Triple Science	Number of schools entering pupils for Triple Science
Maintained School	*Mixed sex*	3550	56%	1998
	Female	249	67%	166
	Male	320	43%	137
	Total	4119	*Average* 56%	2301
Independent School	*Mixed sex*	532	56%	297
	Female	283	52%	147
	Male	172	30%	51
	Total	987	*Average* 50%	495

Taking all the schools together from both state maintained and independent sectors, on average just 54% of the 5,106 schools in England entered their pupils for Triple Science GCSEs. For mixed-sex schools, an equal proportion of state maintained and independent sector schools, at 56%, entered pupils for Triple Science GCSEs. For single-sex schools however, perhaps contrary to popular belief, a higher proportion of schools in the state maintained sector entered their pupils for Triple Science compared with independent schools.

For single-sex girls schools, 67% in the maintained sector entered girls for Triple Science compared whilst just 52% of schools in the independent sector did so. The same trend exists for boys, but with substantially lower proportions; 43% of state maintained schools and only 30% of independent schools.

The finding that on average only 54% of schools in England entered pupils for Triple Science gives cause for concern. This cannot be attributed to ability alone, but points to a lack of opportunity for many thousands of young people across the country.

Where schools did enter pupils for Triple Science, there were significant disparities between state maintained and independent sectors in the number of pupils taking up the option. Table 10 shows the proportions of pupils entered for triple science as a percentage of the total cohort.

In general, the results show that in those schools where pupils are entered for triple science, a much greater proportion of the year cohort will be entered at independent schools compared with state maintained schools. This appears true irrespective of mixed-sex or single-sex schools.

The proportion of state maintained school pupils entered for triple science tends to peak around 11–25% of the year cohort. This would seem to suggest that these schools are streaming by ability, and the 'top set' are being entered for triple science GCSEs.

TABLE 10: Proportion of pupils entered for Physics GCSE by end of Key Stage 4 by type of school and gender of school for England 2009/10

School type	Gender of School	Proportion of pupils (of the total cohort) entered for triple science						Number of schools entering pupils for Triple Science
		1% to 10%	11% to 25%	26% to 40%	46% to 55%	56% to 90%	91% to 100%	
Maintained School	*Mixed*	11%	**31%**	10%	3%	1%	1%	1998
	Female	7%	**29%**	14%	7%	6%	6%	166
	Male	3%	**13%**	8%	5%	5%	8%	137
Independent School	*Mixed*	3%	7%	13%	12%	**17%**	3%	297
	Female	2%	8%	13%	10%	**14%**	5%	147
	Male	2%	2%	2%	5%	**12%**	6%	51

8.2 Entry to Triple Science by school size

The low proportion of schools in the independent sector which enter pupils for Triple Science may be explained by the size of the cohort in each school. To better understand this, it is useful to examine participation in Triple Science by size of school, shown in Table 11 below.

The data shows that the vast majority of schools with fewer than 50 pupils in the Key Stage 4 cohort did not enter any pupils for Triple Science. This is likely to be due to the lack of specialist teachers in such small schools. A significant proportion of larger schools enter pupils for triple science, but these tend to be small proportions of pupils within the schools. For mid-sized schools with 50-99 pupils a significant proportion of them enter over half their pupils. These results again infer a pattern of schools streaming pupils with the 'top set' being entered for triple science.

Since 2010 there have been further increases in the proportion of pupils taking Triple Science qualifications[24] rising to approximately 20% of the cohort attain A*–C in physics, chemistry and biology and this is welcome.

Research by the Department for Education suggests that pupils participating and achieving in triple science are more likely to achieve high grades in level 3 qualifications in science and engineering subjects[25].

However, if as the data suggests only high ability pupils are being given the opportunity to take individual physics, chemistry and biology qualifications, then it is self-fulfilling that these pupils will be successful in level 3 STEM qualifications. That is, it is not the qualifications, per se, that are making the pupils achieve better grades at A level, but rather the ability of the pupils.

While it is recognised that triple science is not appropriate for all pupils, increased participation in the individual sciences may lead to a greater proportion of pupils considering progression in science, engineering and technology subjects. There must therefore be a concern that policies being pursued by government that will act to disincentivise greater uptake of the individual sciences.

First, the English Baccalaureate (E-Bac) may act to disincentivise schools from offering triple science, as the accountability measure can be achieved by pupils successfully gaining A*–C grades in Double Science. This then allows schools to focus more attention on other subjects within the E-Bac.

Head teachers and school governors must examine policies on provision and participation of pupils in science and mathematics subjects and make efforts to increase take-up of triple science where appropriate.

Government should also keep a watchful eye on participation and attainment in triple science as the E-Bac becomes a more established accountability measure and take action if the number of pupils taking all three science qualifications begins to decrease.

The second concern is about participation in small schools. As the data in Table 10 demonstrates, smaller schools enter fewer pupils for triple science GCSEs. While the reason is not clear, the very low participation rates for small schools may point to a lack of specialist teaching staff across the three science disciplines of biology, chemistry and physics.

This issue of lack of specialist teaching expertise in small schools in turn raises questions about the promotion of new 'free schools' and academies. If the pursuit of this policy leads to a trend in smaller school cohorts, we may see a consequent reduction in the proportions of pupils taking Triple Science, as small schools struggle to sustain appropriately specialist teaching staff across the three science disciplines.

Government must again to monitor participation in triple sciences as the number of Academies and Free schools increases and take appropriate action if participation in triple science begins to decrease as a consequence of the introduction of these schools.

TABLE 11: Proportion of pupils entered for Triple Science GCSE by end of Key Stage 4 by size of school for England 2009/10

Size of School year group at Key Stage 4	Not entering pupils for Triple Science	Proportion (of the total cohort) of pupils entered for Triple Science GCSE			Total number of schools
		between 1% and 20%	between 21% and 50%	greater than 50%	
Fewer than 10 pupils	95%	1%	2%	2%	639
between 10 and 49 pupils	79%	5%	10%	6%	995
between 50 and 99 pupils	38%	12%	26%	25%	426
between 100 and 199 pupils	29%	37%	24%	10%	1851
greater than 200 pupils	17%	47%	33%	2%	1195
Total	45%	27%	21%	8%	5106

24 GCSE and equivalent results in England. Statistical First Release SFR02/2012 Department for Education www.education.gov.uk

25 Maths and science education: the supply of high achievers at A level. Research report 079. Department for Education www.education.gov.uk

Conclusions

This research has examined participation and attainment in science and mathematics qualifications at the end of key stage 4 in schools in England in 2010. Data was examined on a national level, a sub-regional level and at Local Authority level.

Data on entry and attainment for triple science (individual physics, chemistry and biology GCSEs), double science (core science and additional science or applied science GCSEs), vocational science qualifications – BTEC first and OCR nationals was studied. Vocational engineering qualifications taken at key stage 4 were also included in the latter group as these provide a similar opportunity of progression for pupils.

Participation in triple science by different school types was also compared across state maintained schools and independent schools. Mixed sex schools and single sex schools in both sectors were examined as was the effect of school size on participation in triple science GCSEs.

The following results were found:

National attainment in science and mathematics

- 16% of pupils achieved triple science **and** mathematics GCSEs.
- Fewer than half (49.5%) of pupils achieved a combination of what is considered to be a minimum number of qualifications for progression towards science, engineering and technology (SET) roles; A*–C grades in at least two science GCSEs (or equivalent) and GCSE mathematics.
- Nationally, 39% of pupils did not achieve A*–C in GCSE mathematics (or equivalents)

Regional analysis

- There was significant regional variation in both entry and attainment that shows a tendency towards a "science south"
- In four Local Authorities, over a quarter of pupils were not entered for any science qualification
- There was significant variation at Local Authority level. Trafford had the highest participation and attainment in science and mathematics in England, with 67% of pupils achieving the minimum number of qualifications for progression in SET roles
- The Borough of Sutton, in London had 39% of pupils entered for triple science and 38% achieving A*–C grades in all three sciences and mathematics GCSEs.
- Halton in Merseyside had the lowest participation in science in England with only 54% of the cohort being entered for two or more science qualifications.
- Blackpool had the lowest attainment. Only 31% of pupils achieved the combination of A*–C grades in two science GCSEs (or equivalent) and A*–C grade in mathematics GCSE.

Participation in triple science by school type

- Single sex state maintained schools are more likely than their independent sector counterparts to offer triple science
- Independent schools that do offer triple science are much more likely to have a high proportion of their pupils taking it
- Small schools (those less than 50 pupils in any year) are highly unlikely to offer triple science

Annex A

Additional figures on participation in sciences at key stage 4 across England

FIGURE A1A: Proportion of pupils entered for Triple Science GCSEs (individual physics, chemistry and biology) at Key Stage 4 across the 41 sub-regions of England in 2010

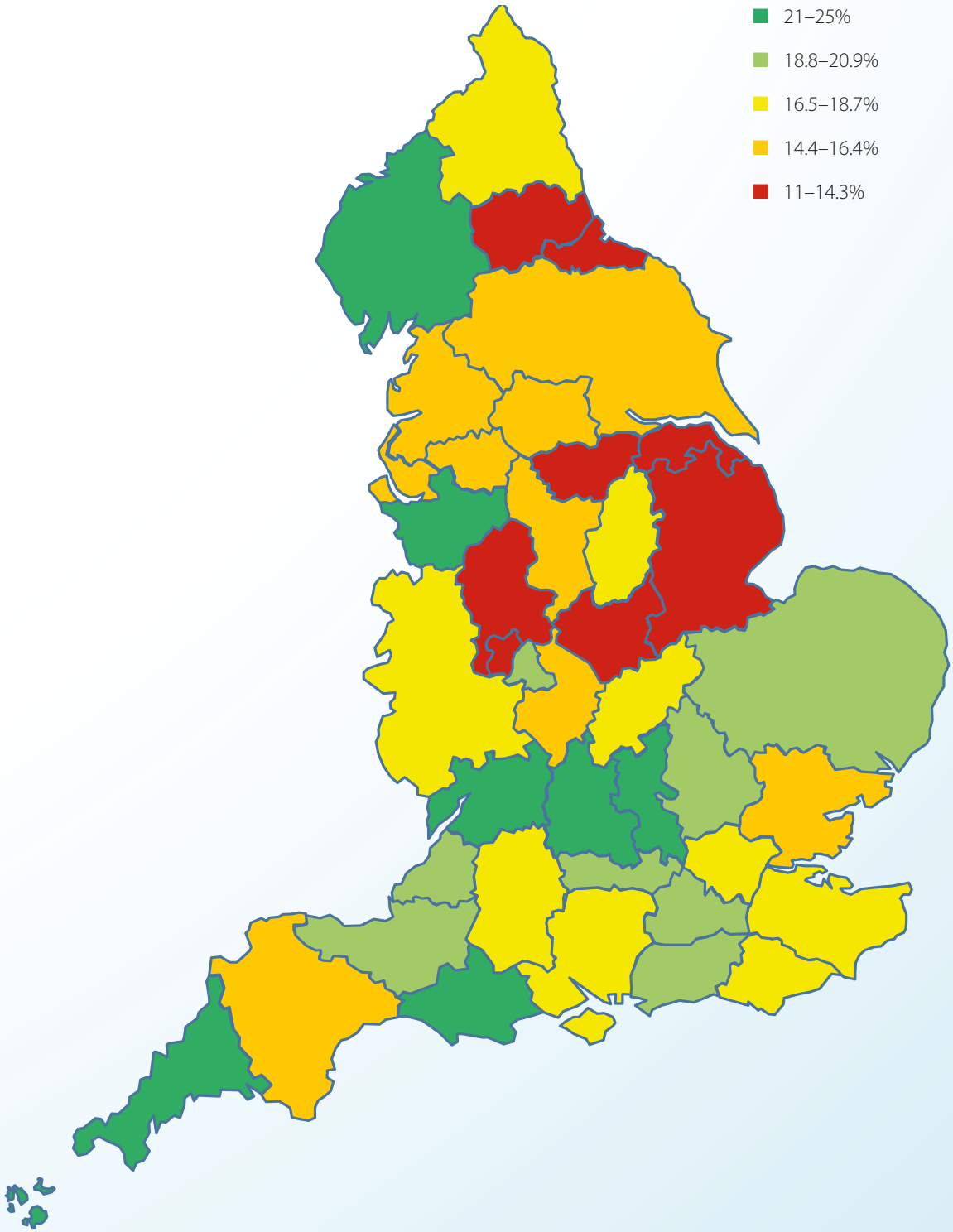


FIGURE A1B: Proportion of pupils entered for Triple Science GCSEs (individual physics, chemistry and biology) at Key Stage 4 across the 152 Local Authorities of England in 2010

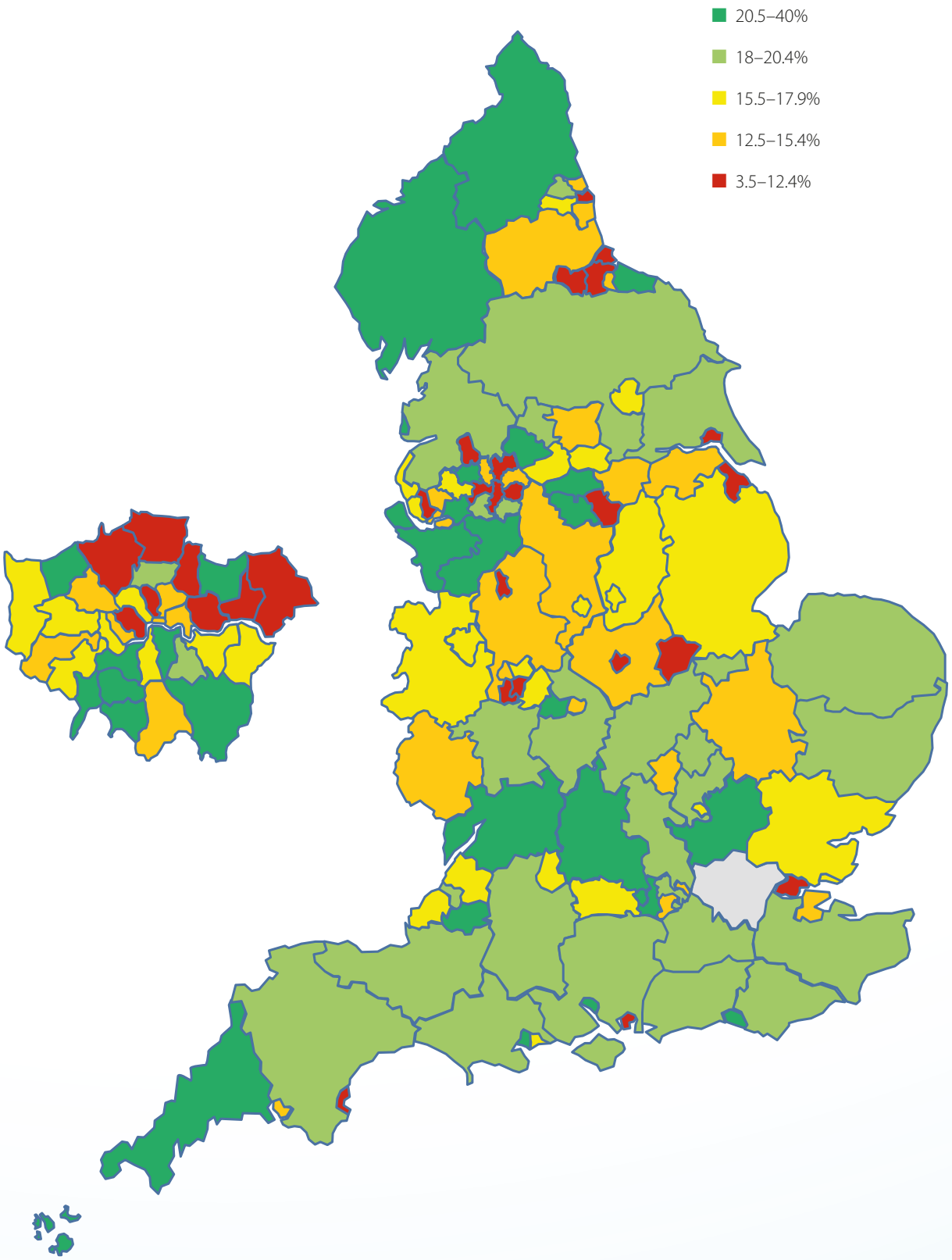


FIGURE A2A: Proportion of pupils entered for Double Science GCSEs (Core *and* Additional *or* Applied) at Key Stage 4 across the 41 sub-regions of England in 2010

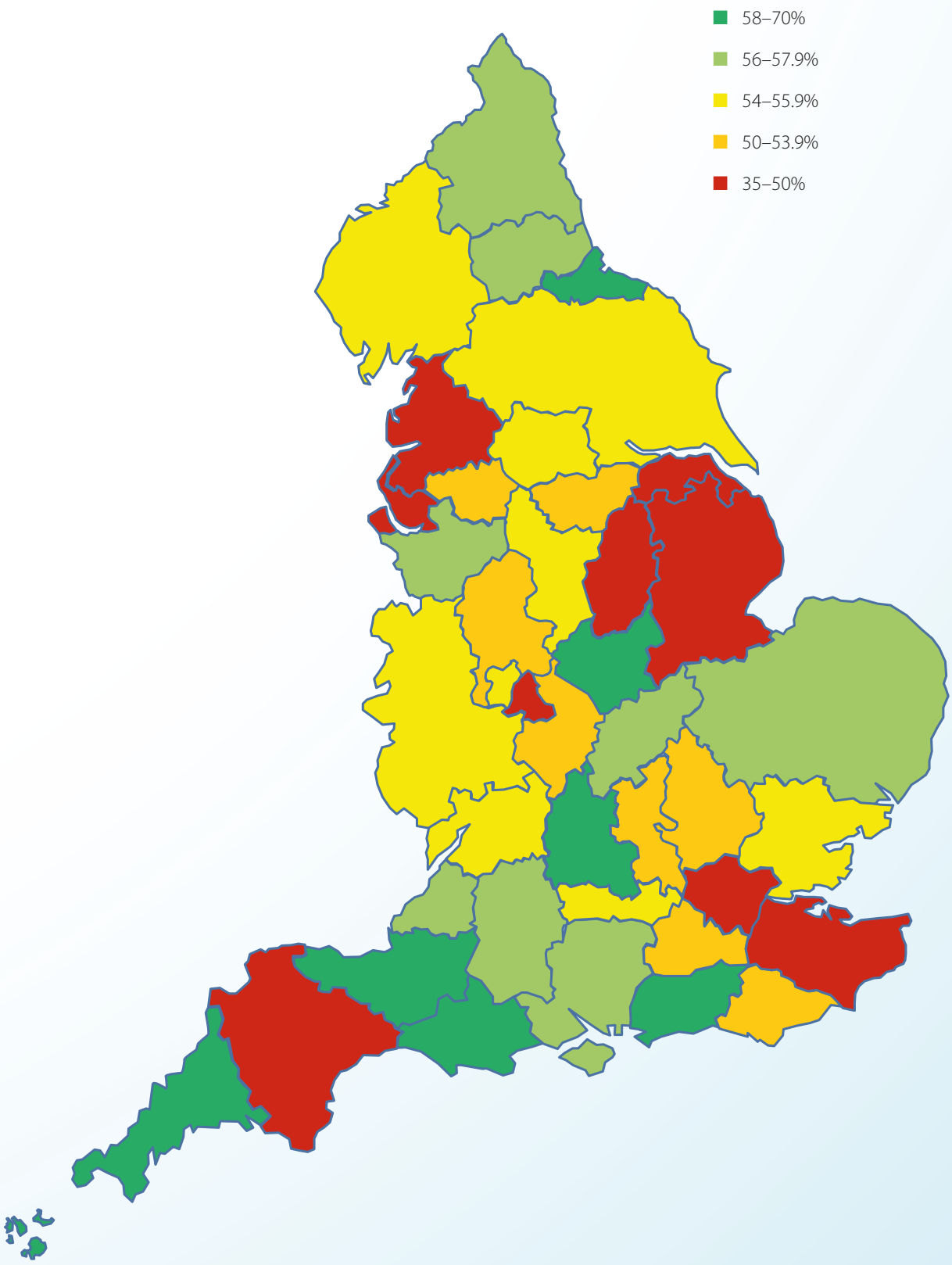


FIGURE A2B: Proportion of pupils entered for Double Science GCSEs (Core *and* Additional *or* Applied) at Key Stage 4 across the 152 Local Authorities of England in 2010

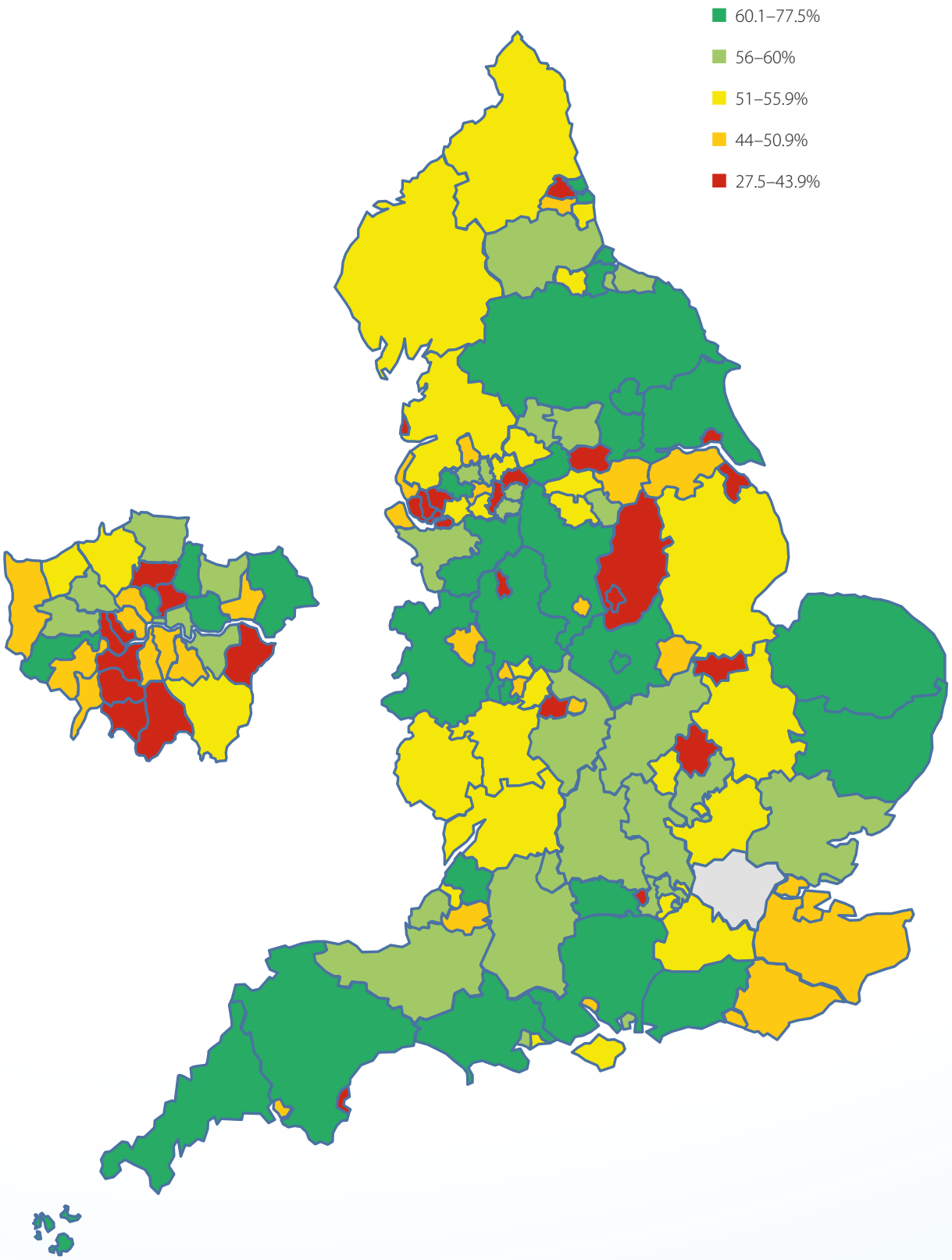


FIGURE A3A: Proportion of pupils entered for Vocational Science or Engineering qualifications (*equivalent to 2 GCSEs*) at Key Stage 4 across the 41 sub-regions of England in 2010

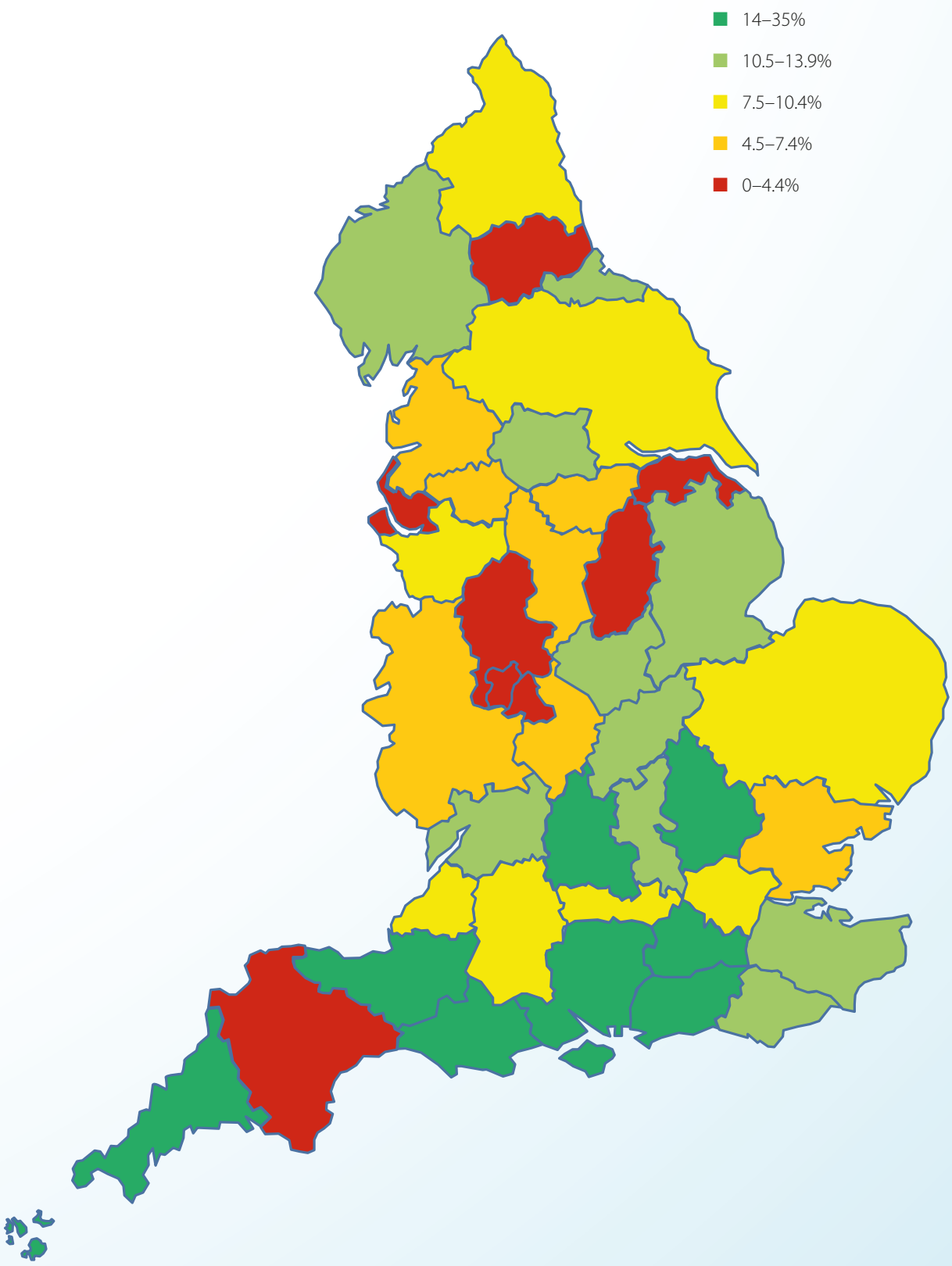


FIGURE A3B: Proportion of pupils entered for Vocational Science or Engineering qualifications (*equivalent to 2 GCSEs*) at Key Stage 4 across the 152 Local Authorities of England in 2010

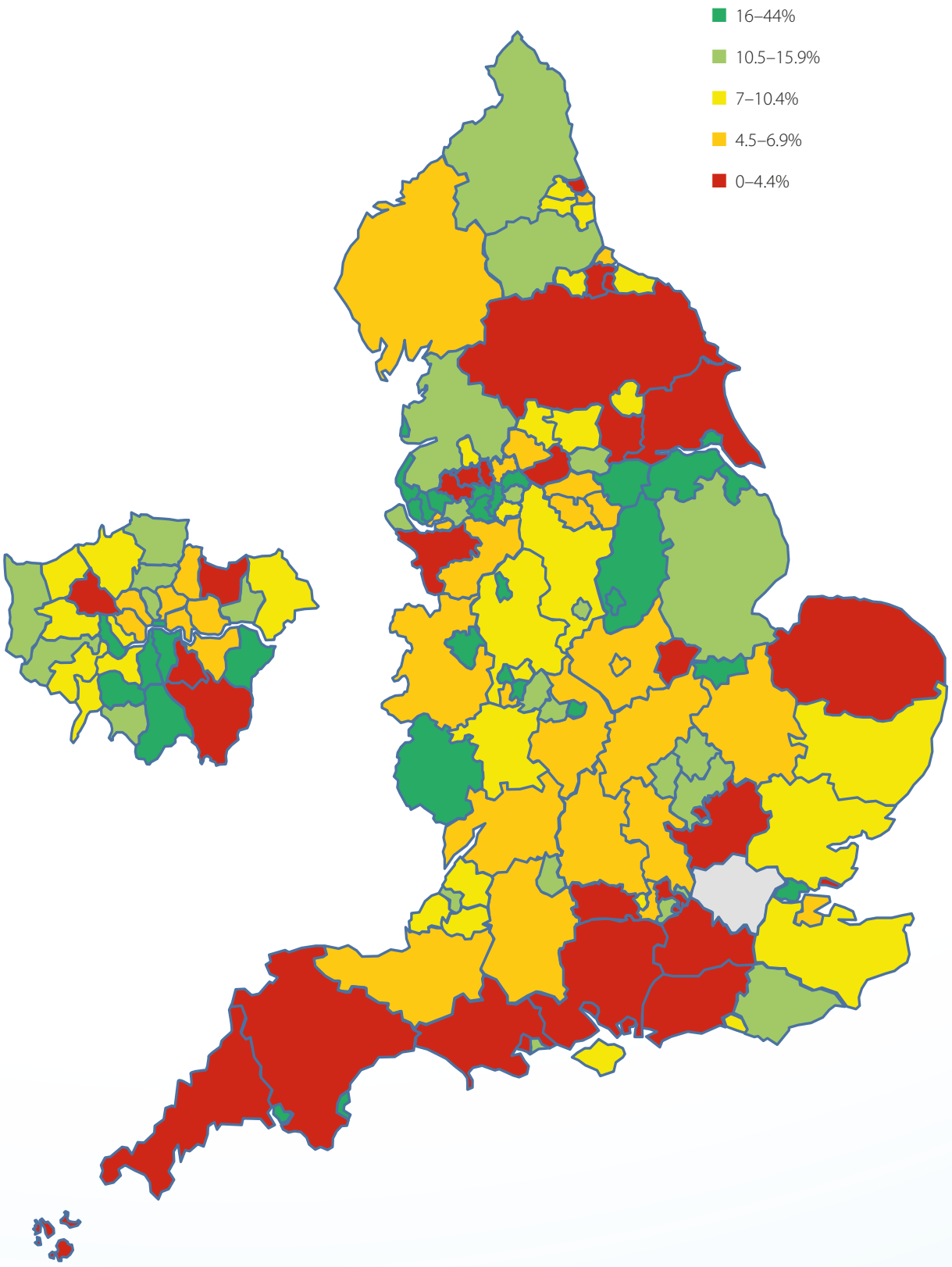


FIGURE A4A: Proportion of pupils entered for a Single Science GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

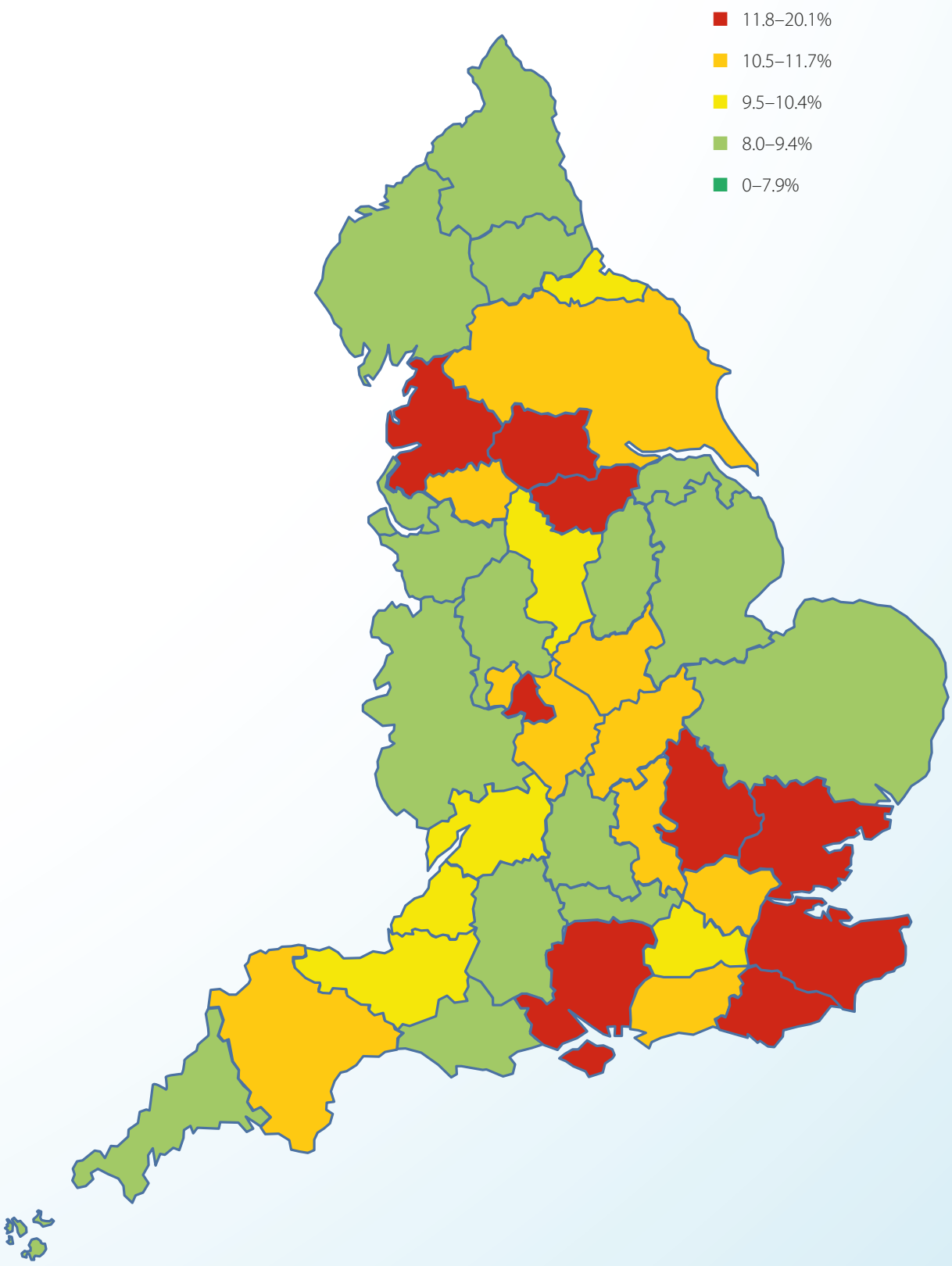


FIGURE A4B: Proportion of pupils entered for a Single Science GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

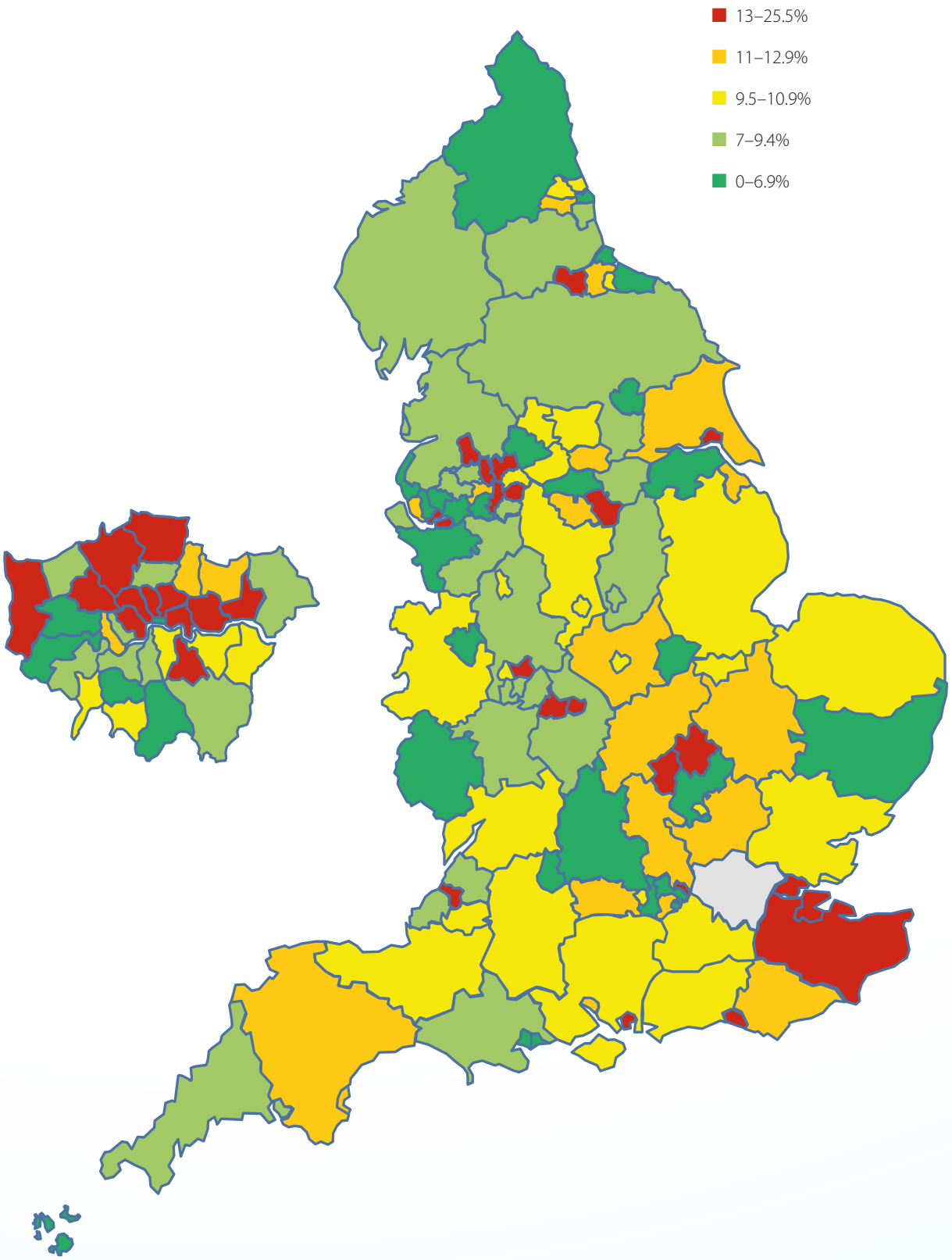


FIGURE A5A: Proportion of pupils who were not entered for any science qualifications at Key Stage 4 across the 41 sub-regions of England in 2010

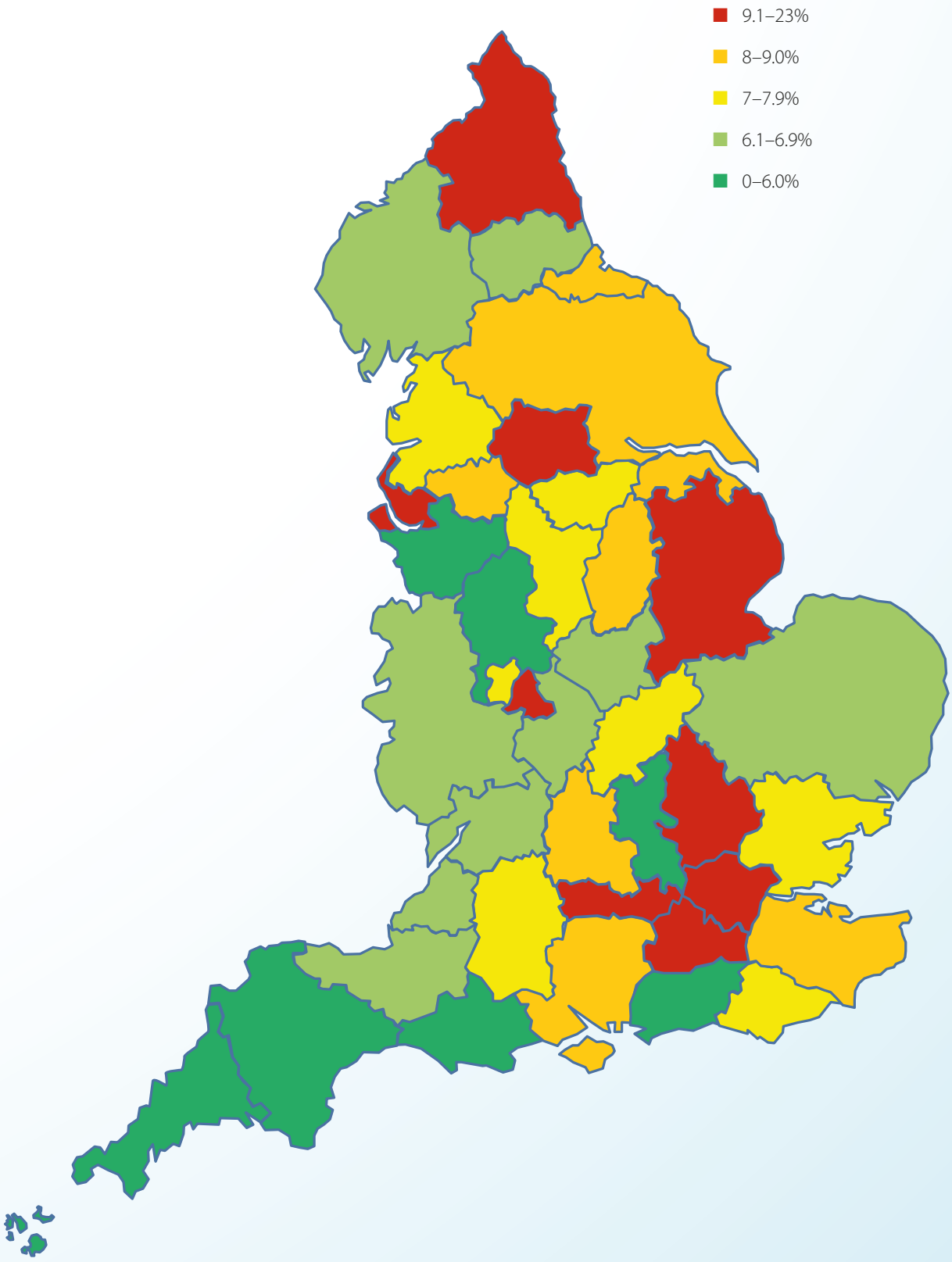
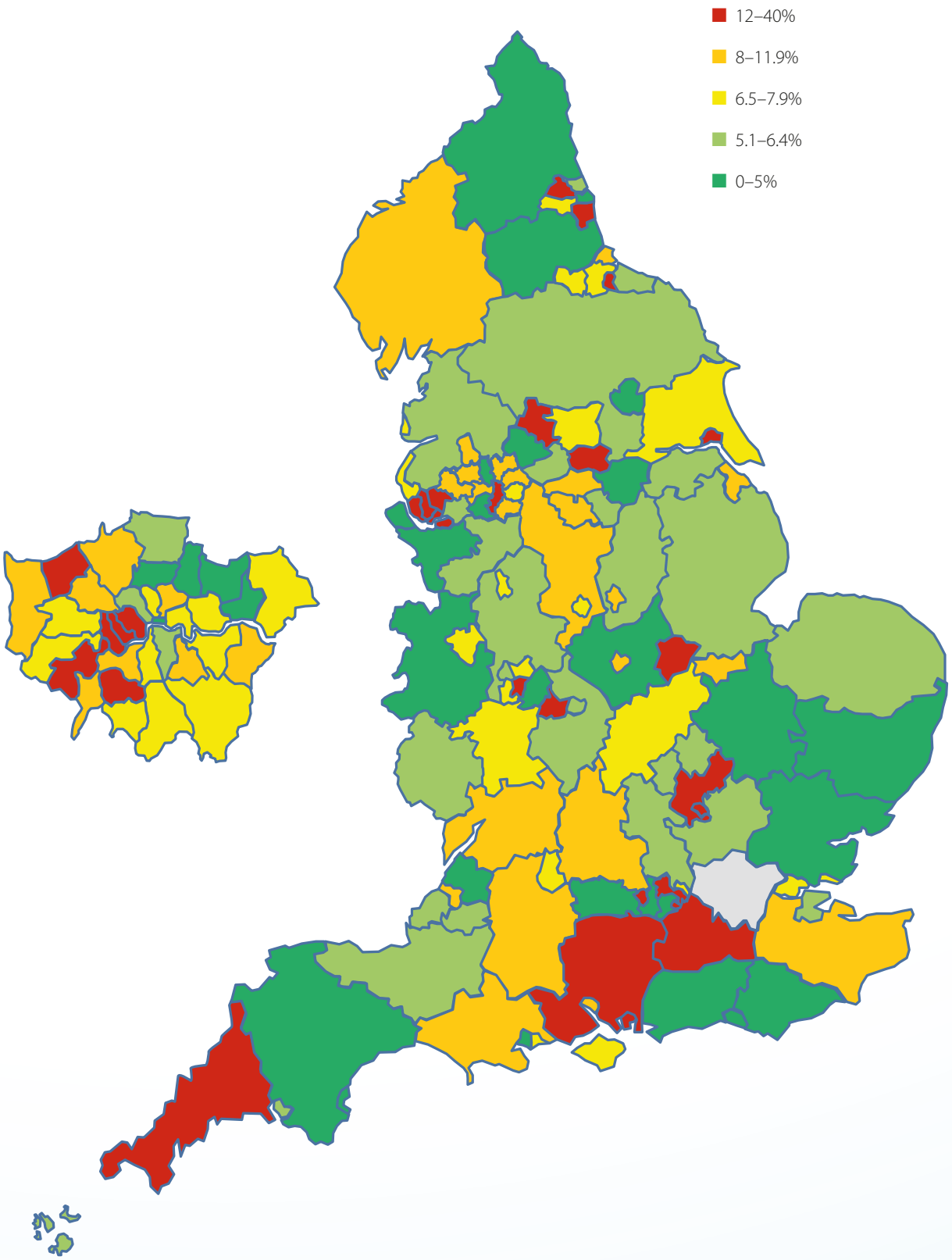


FIGURE A5B: Proportion of pupils who were not entered for any science qualifications at Key Stage 4 across the 152 Local Authorities of England in 2010



Annex B

Additional figures on attainment in science and mathematics at key stage 4 across England

FIGURE B1A: Proportion of pupils who achieved A*–C grade in triple science GCSEs and A*–C grade in mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

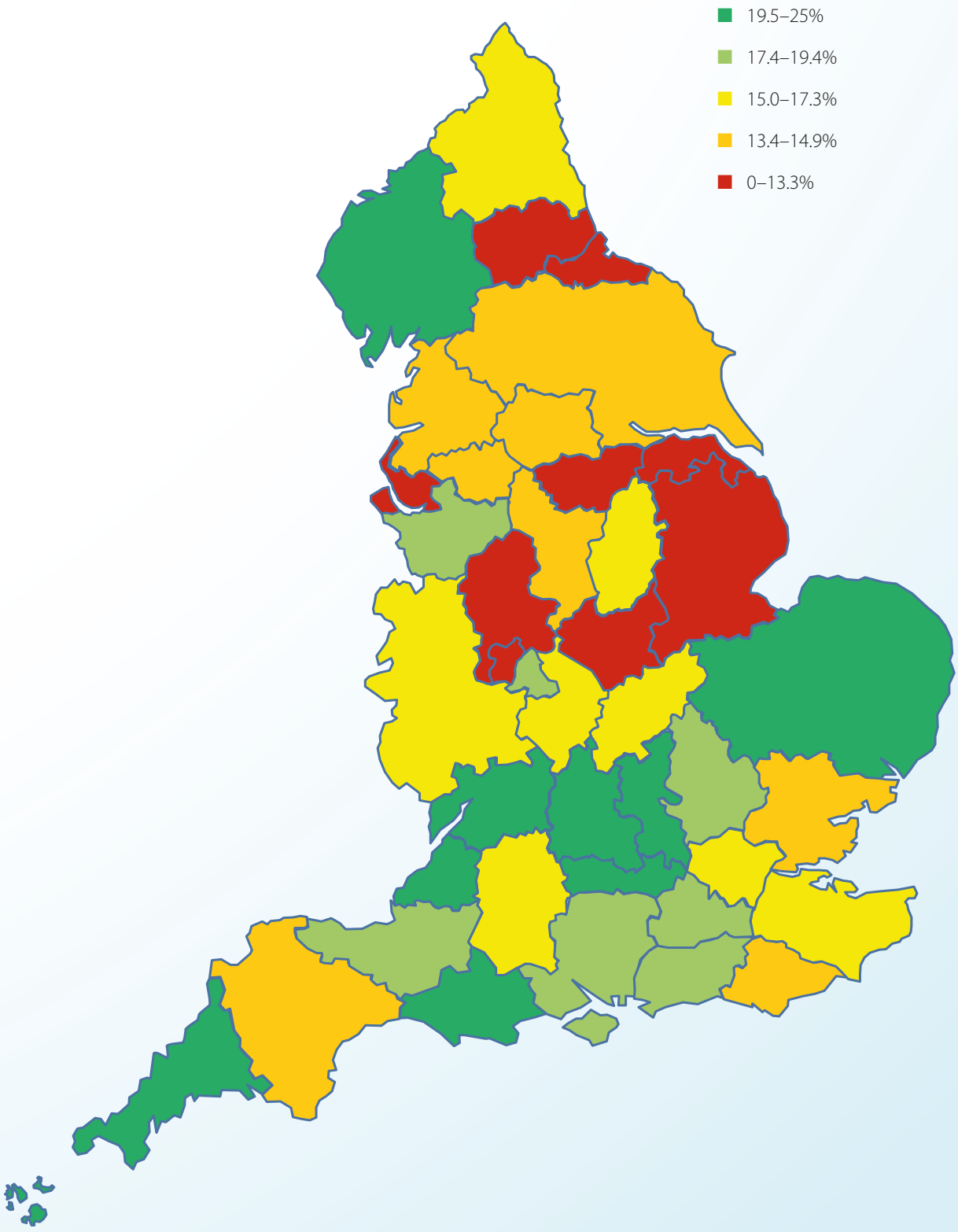


FIGURE B1B: Proportion of pupils who achieved A*–C grade in triple science GCSEs and A*–C grade in mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

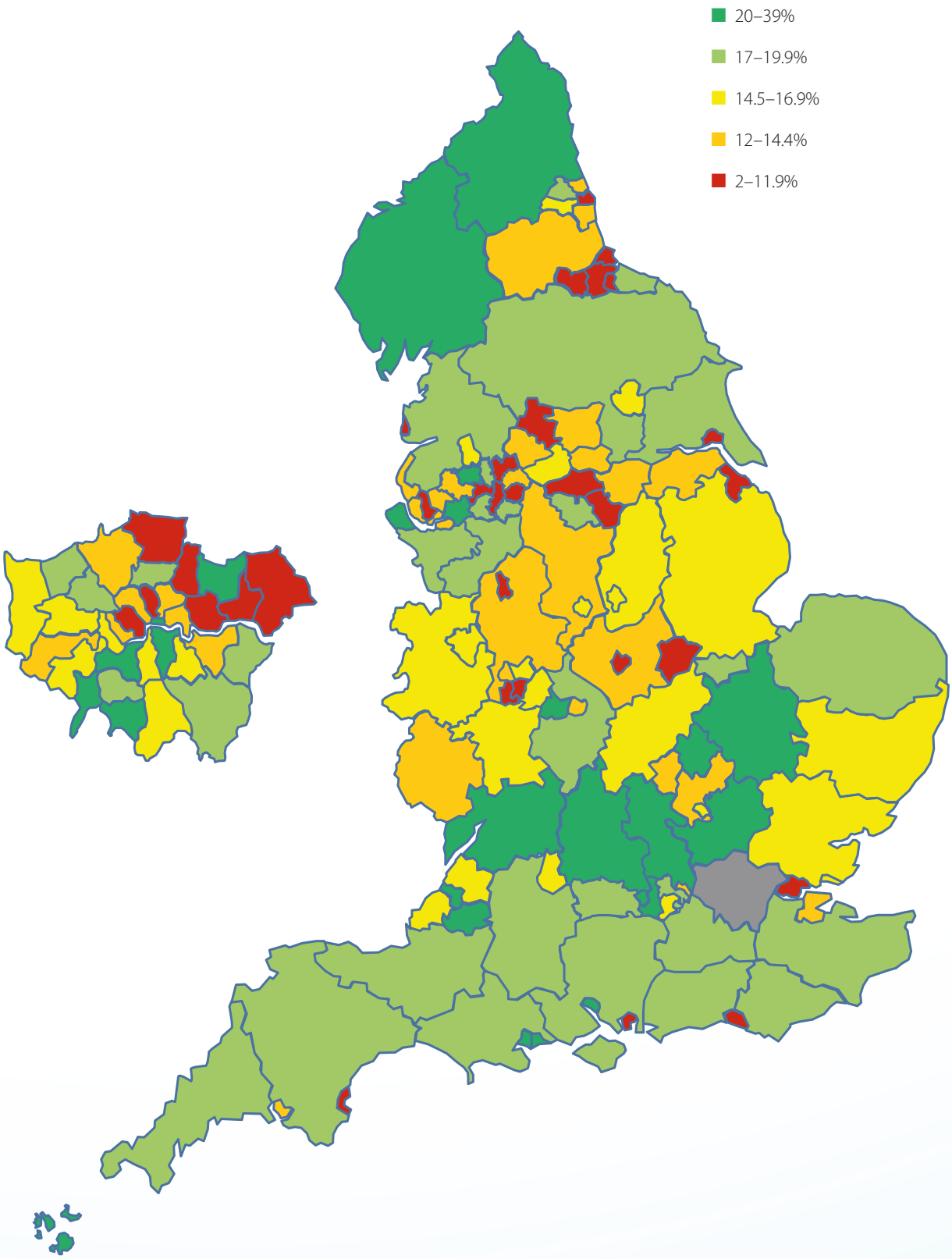


FIGURE B2A: Proportion of pupils who achieved A*–C grade in Double Science (Core *and* Additional *or* Applied) GCSEs and A*–C grade in mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

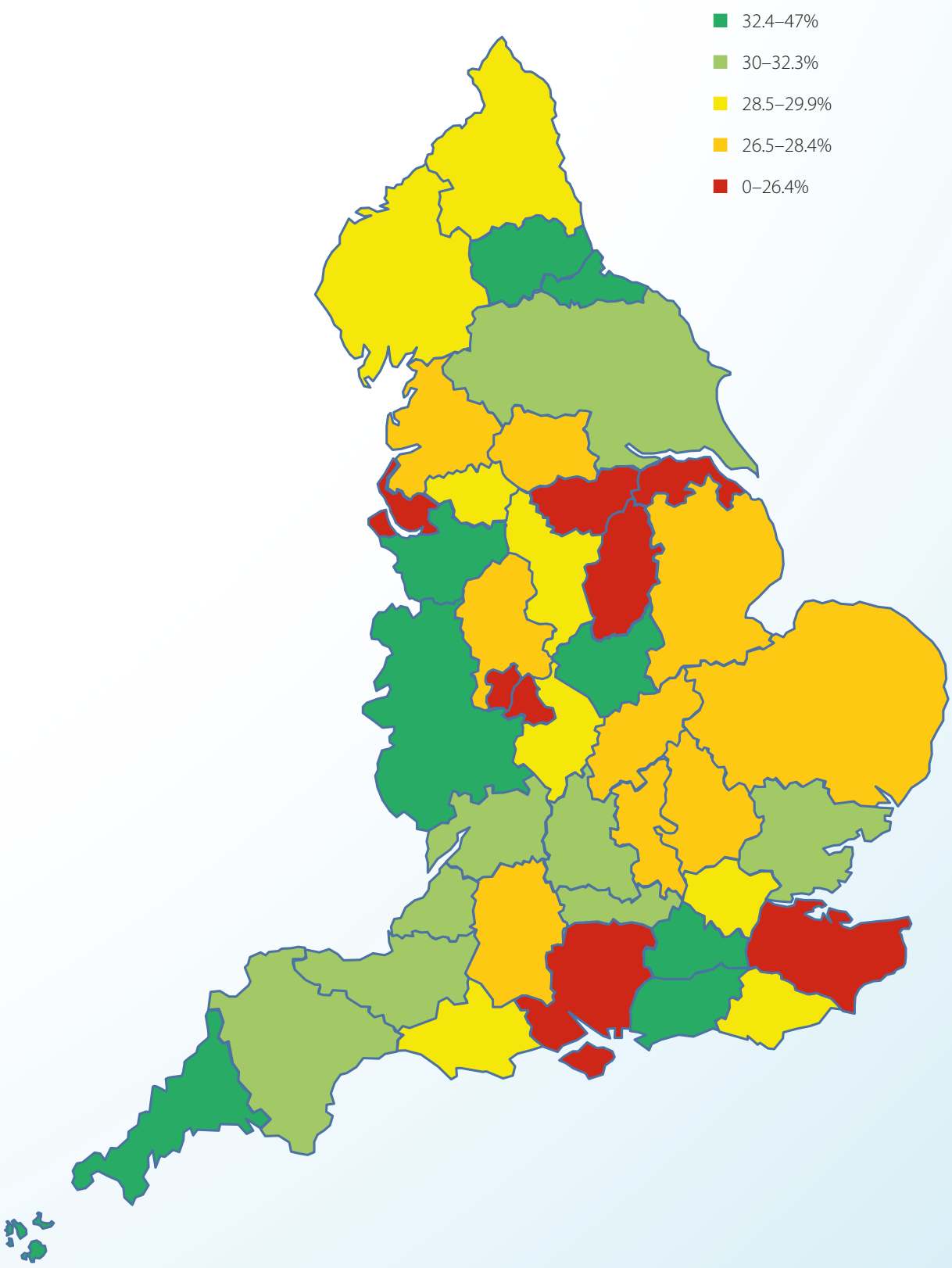


FIGURE B2B: Proportion of pupils who achieved A*–C grade in Double Science (Core and Additional or Applied) GCSEs and A*–C grade in mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

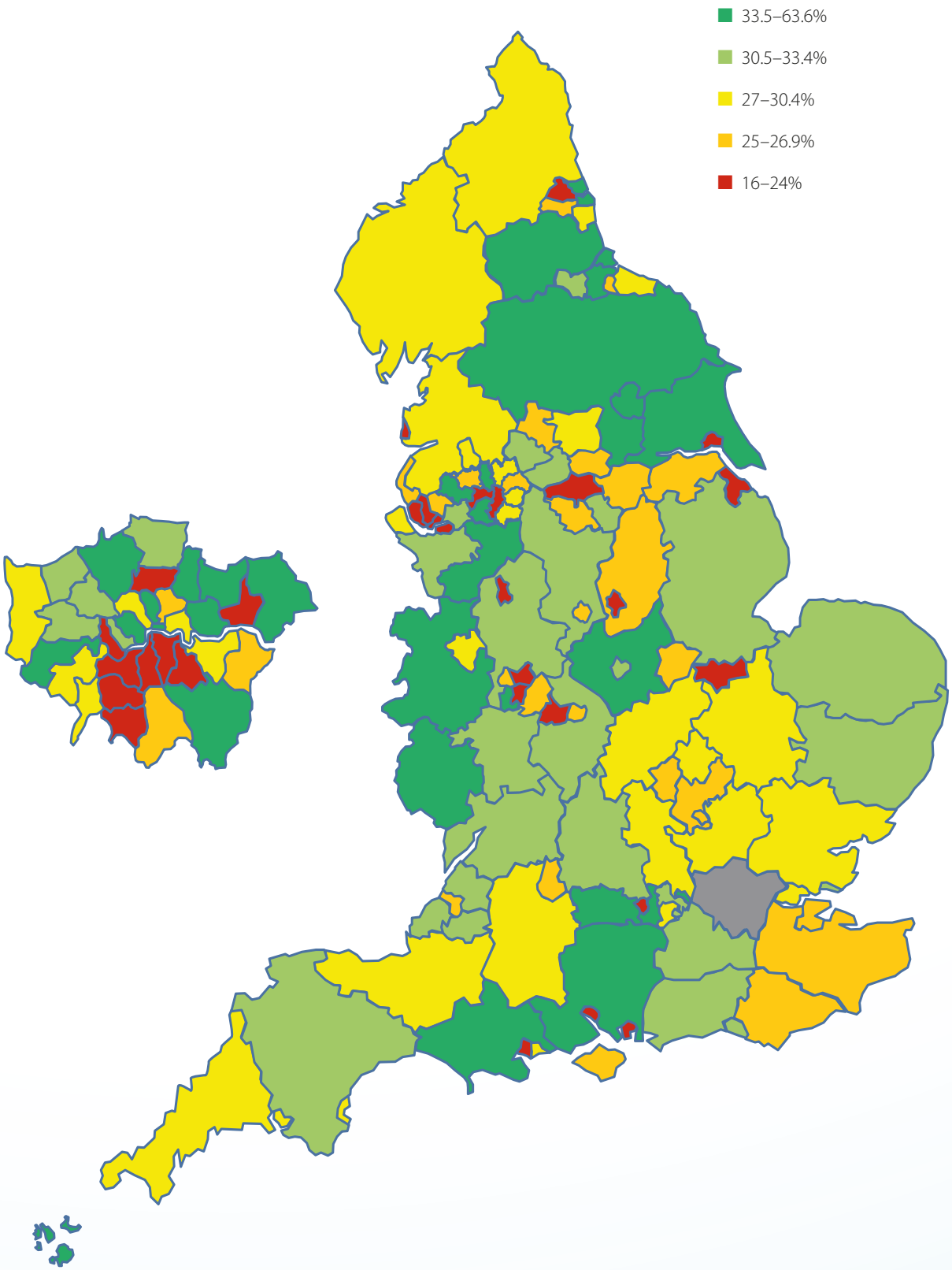


FIGURE B3A: Proportion of pupils who achieved level 2 (equivalent to A*–C grade) in a Vocational Science or Engineering qualification and A*–C grade in Mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

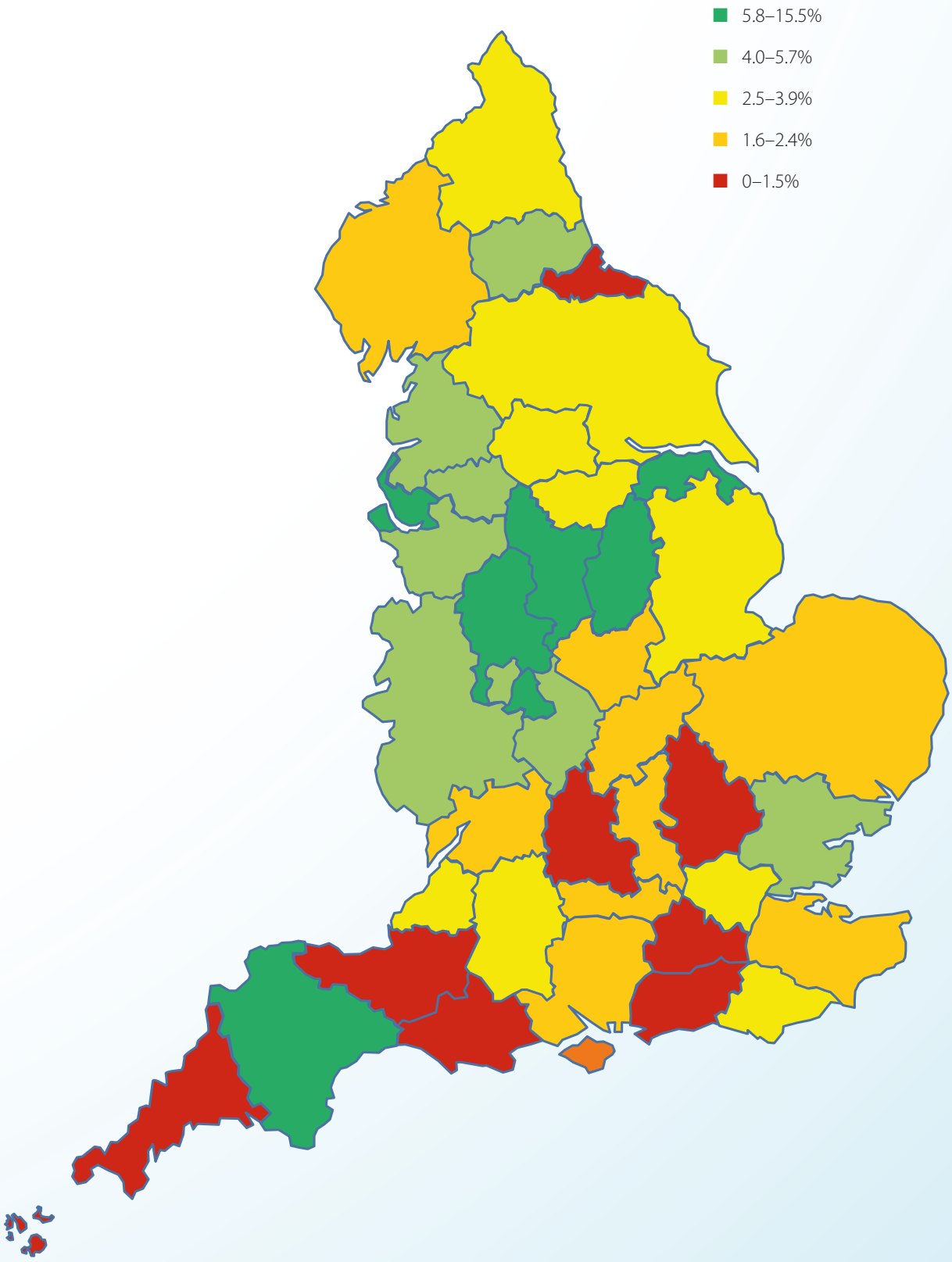


FIGURE B3B: Proportion of pupils who achieved level 2 (equivalent to A*–C grade) in a Vocational Science or Engineering qualification and A*–C grade in Mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

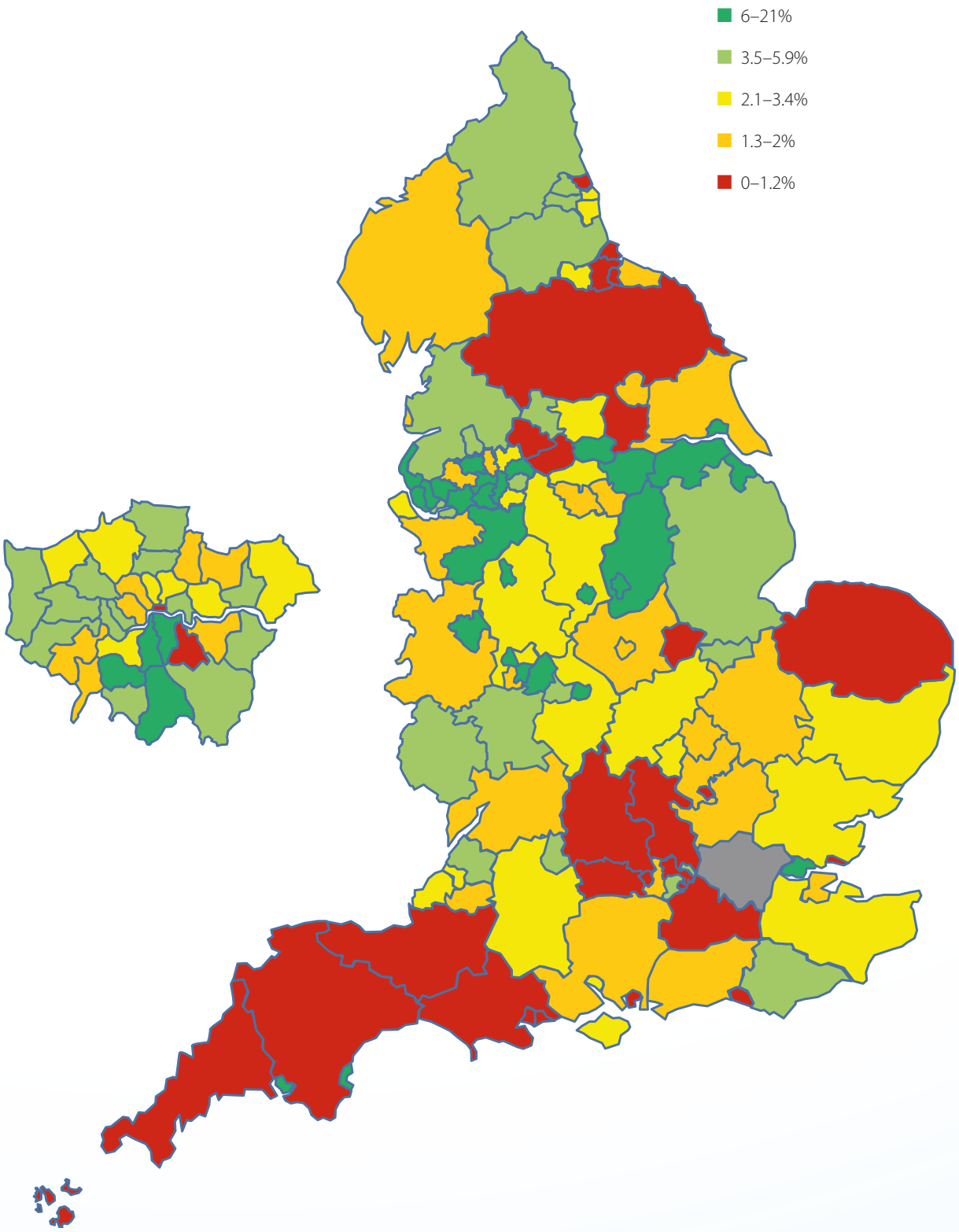


FIGURE B4A: Proportion of pupils who achieved A*–C grade in a Single Science GCSE and A*–C grade in mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

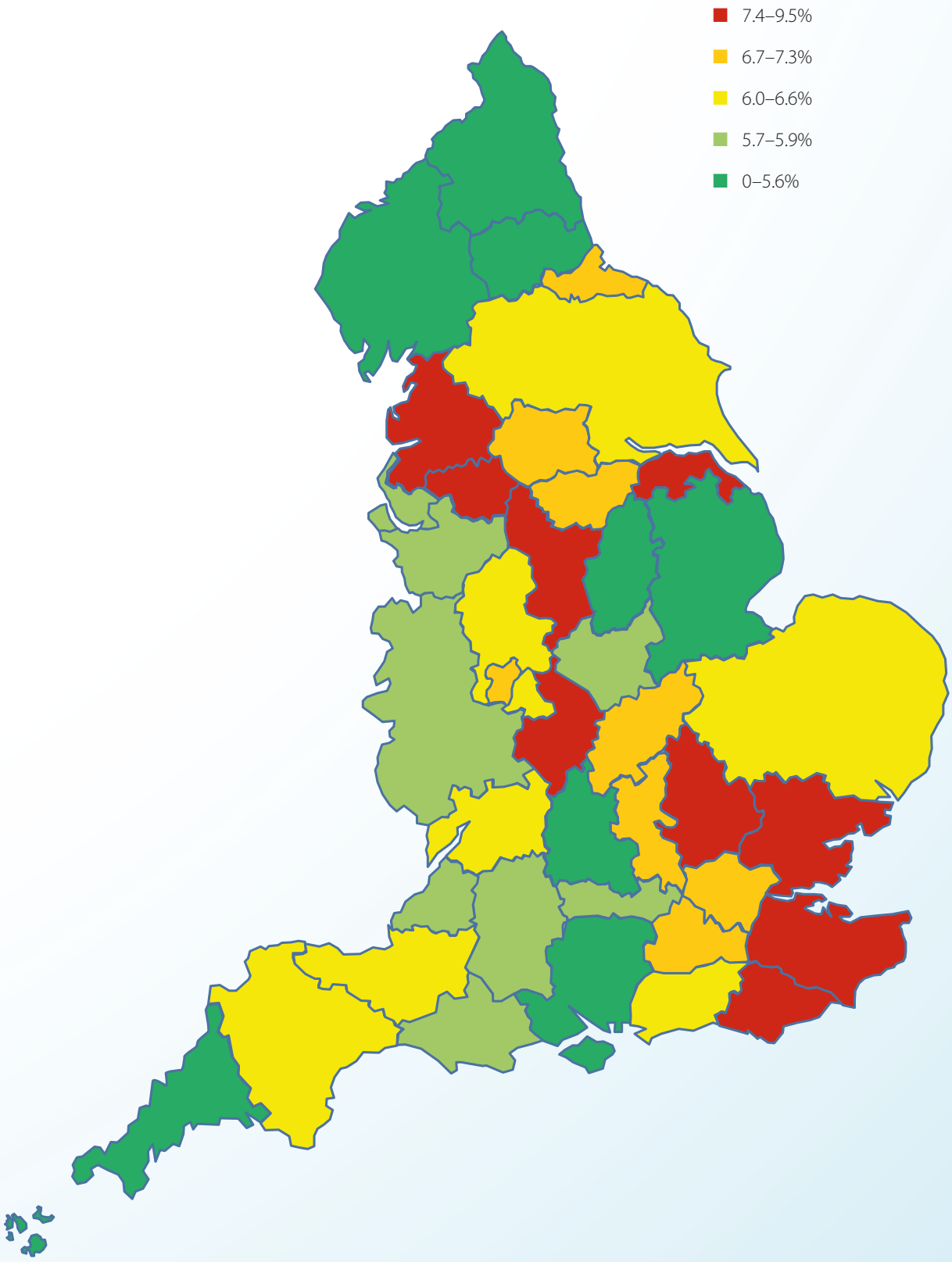


FIGURE B4B: Proportion of pupils who achieved A*–C grade in a Single Science GCSE and A*–C grade in mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

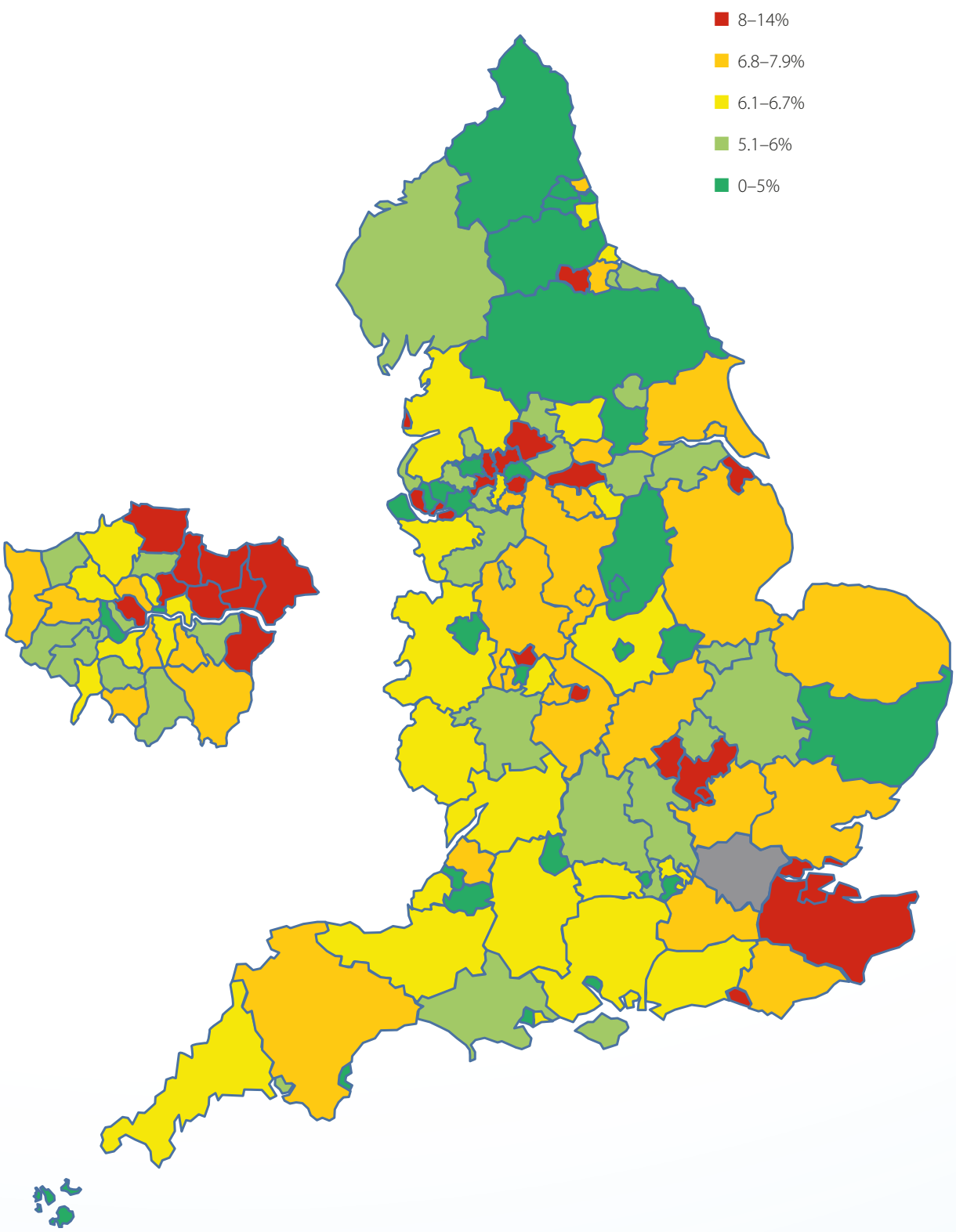


FIGURE B5A: Proportion of pupils who achieved A*–C grade in Mathematics GCSE but did not achieve a A*–C grade in science GCSE or equivalent qualification at Key Stage 4 across the 41 sub-regions of England in 2010

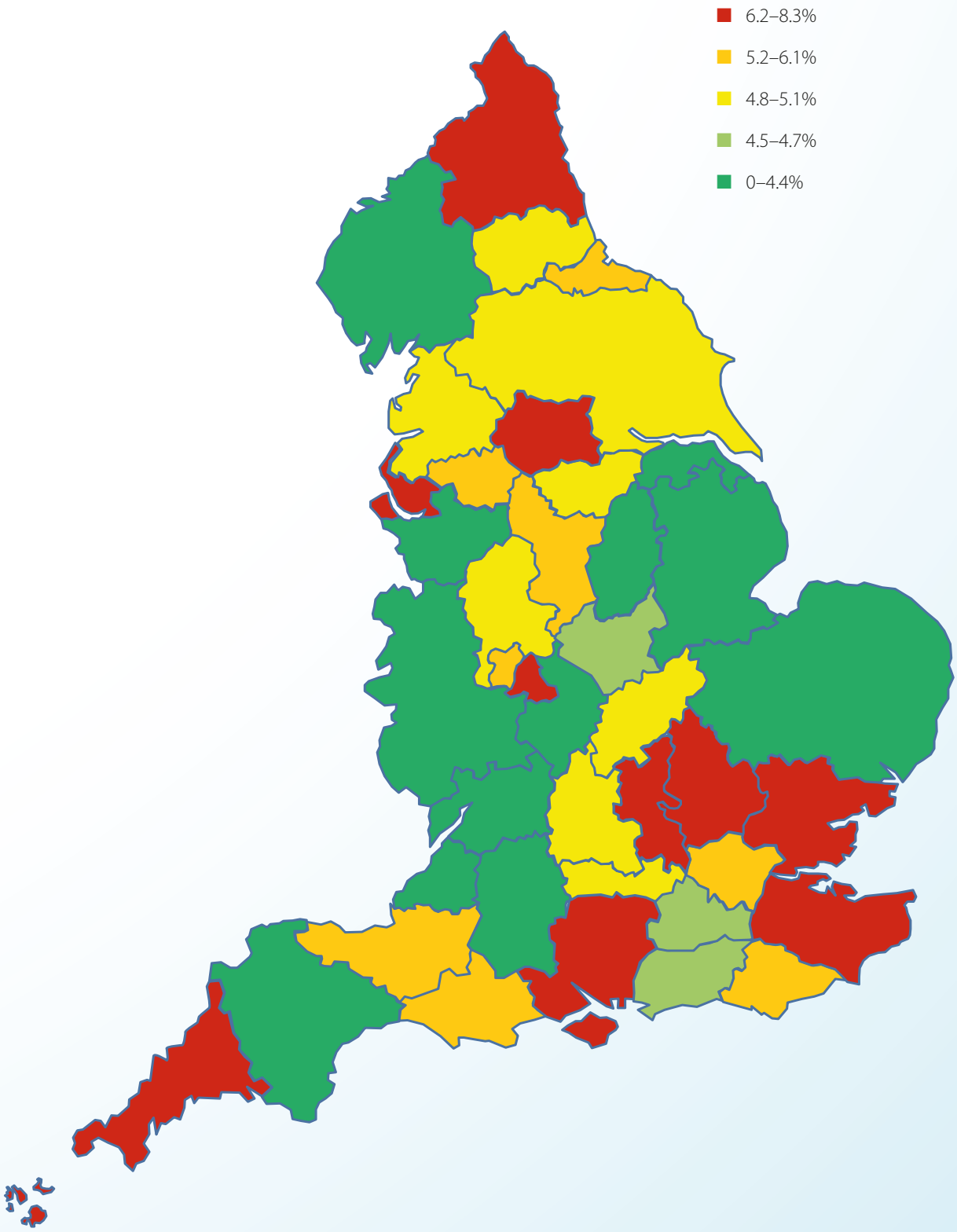


FIGURE B5B: Proportion of pupils who achieved A*–C grade in Mathematics GCSE but did not achieve a A*–C grade in science GCSE or equivalent qualification at level 2 at Key Stage 4 across the 152 Local Authorities in England in 2010

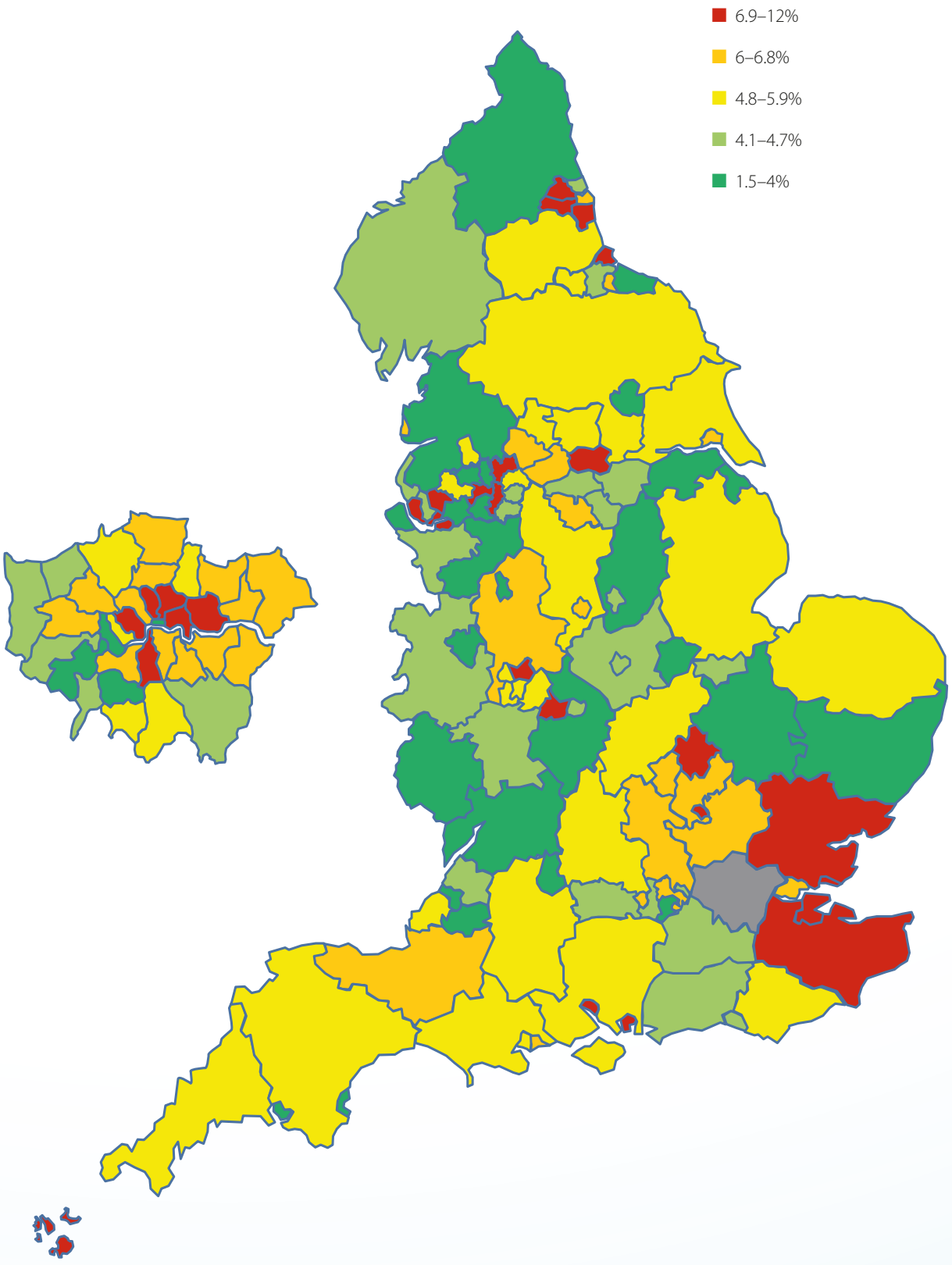


FIGURE B6A: Proportion of pupils who achieved A*–C grade in two or more science GCSEs but did not achieve A*–C grade in Mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

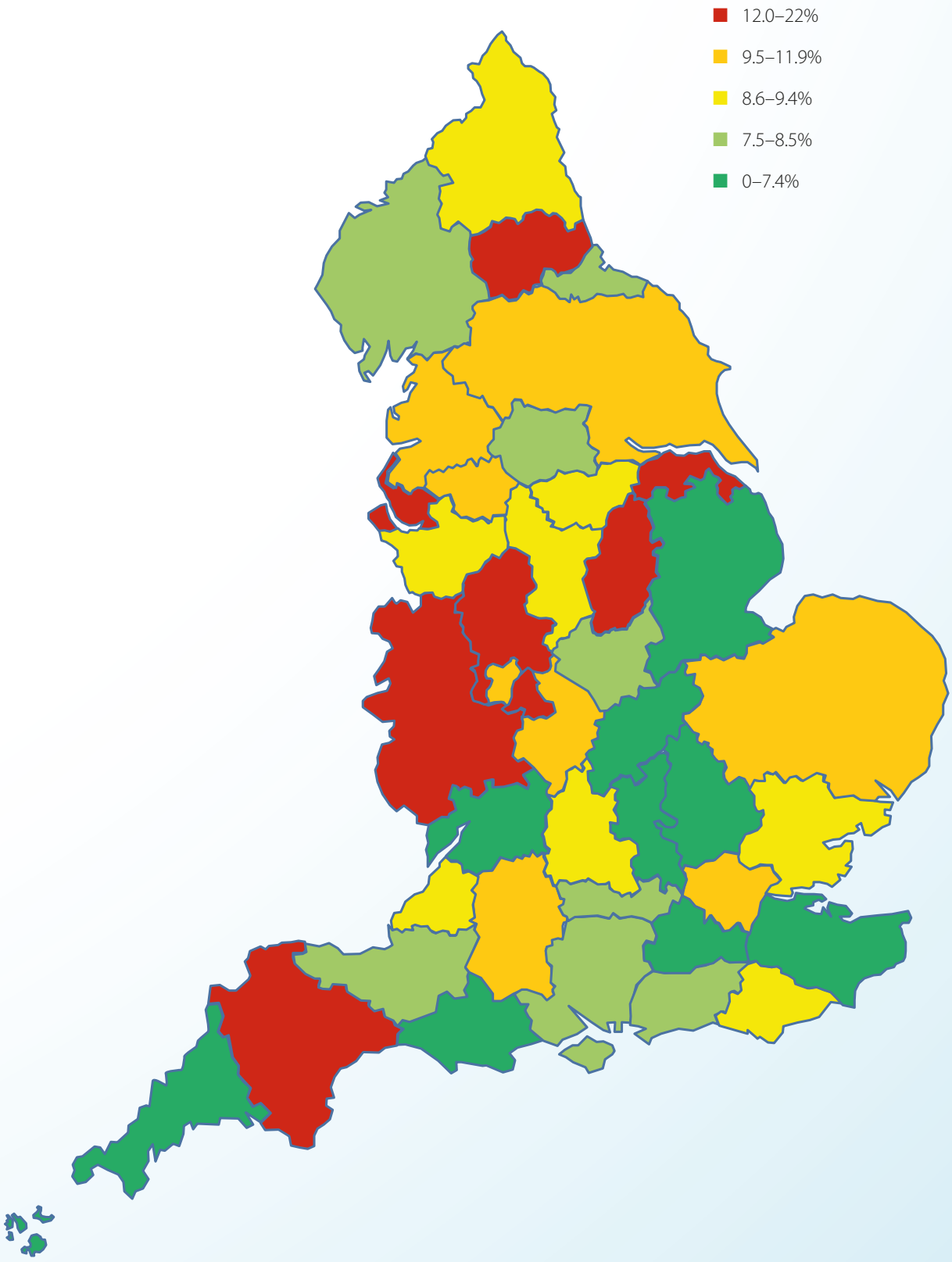


FIGURE B6B: Proportion of pupils who achieved A*–C grade in two or more science GCSEs but did not achieve A*–C grade in Mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

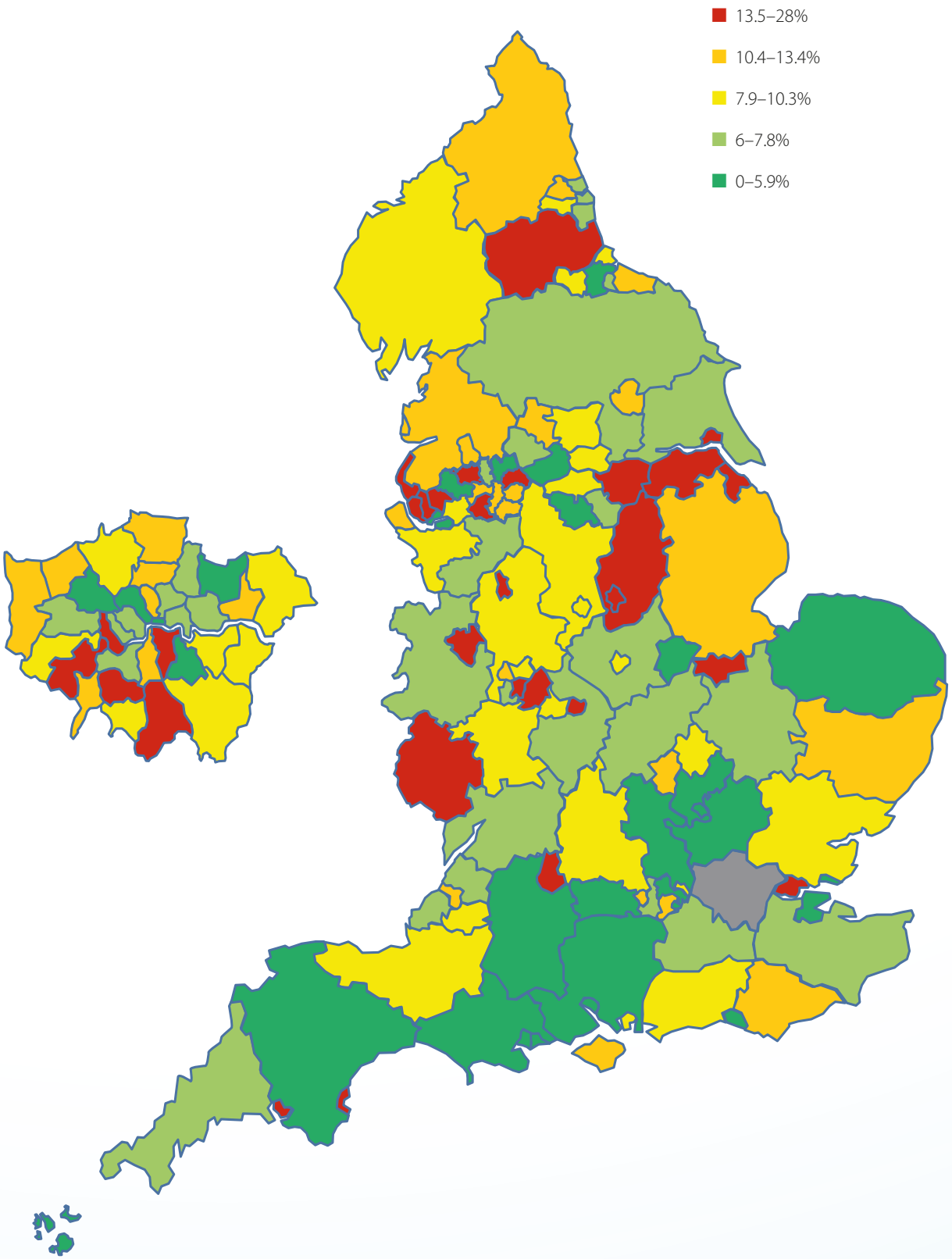


FIGURE B7A: Proportion of pupils who achieved A*-G in a single science GCSE but *did not achieve* A*–C grade in Mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

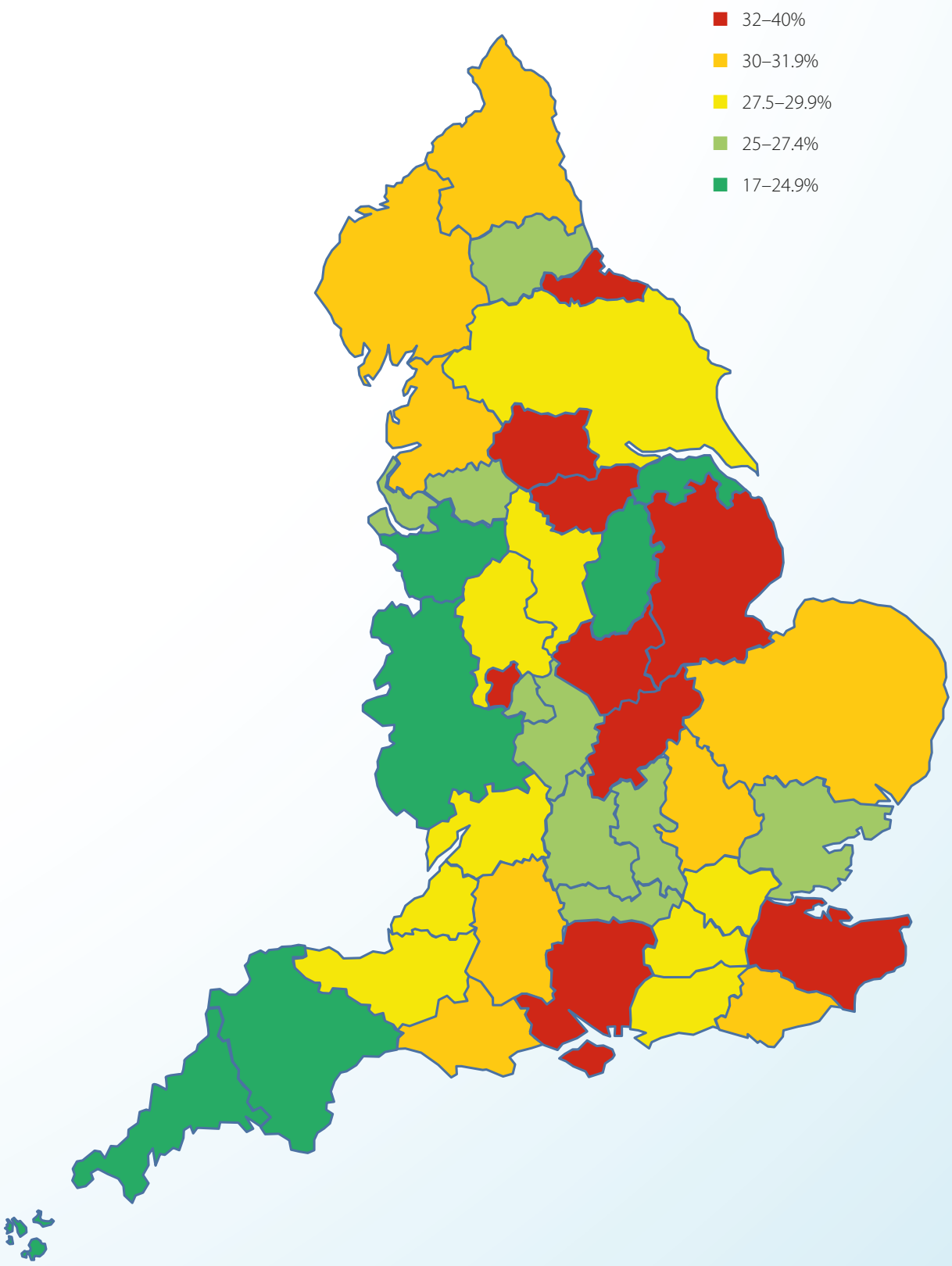


FIGURE B7B: Proportion of pupils who achieved A*-G in a single science GCSE but *did not achieve* A*–C grade in Mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010

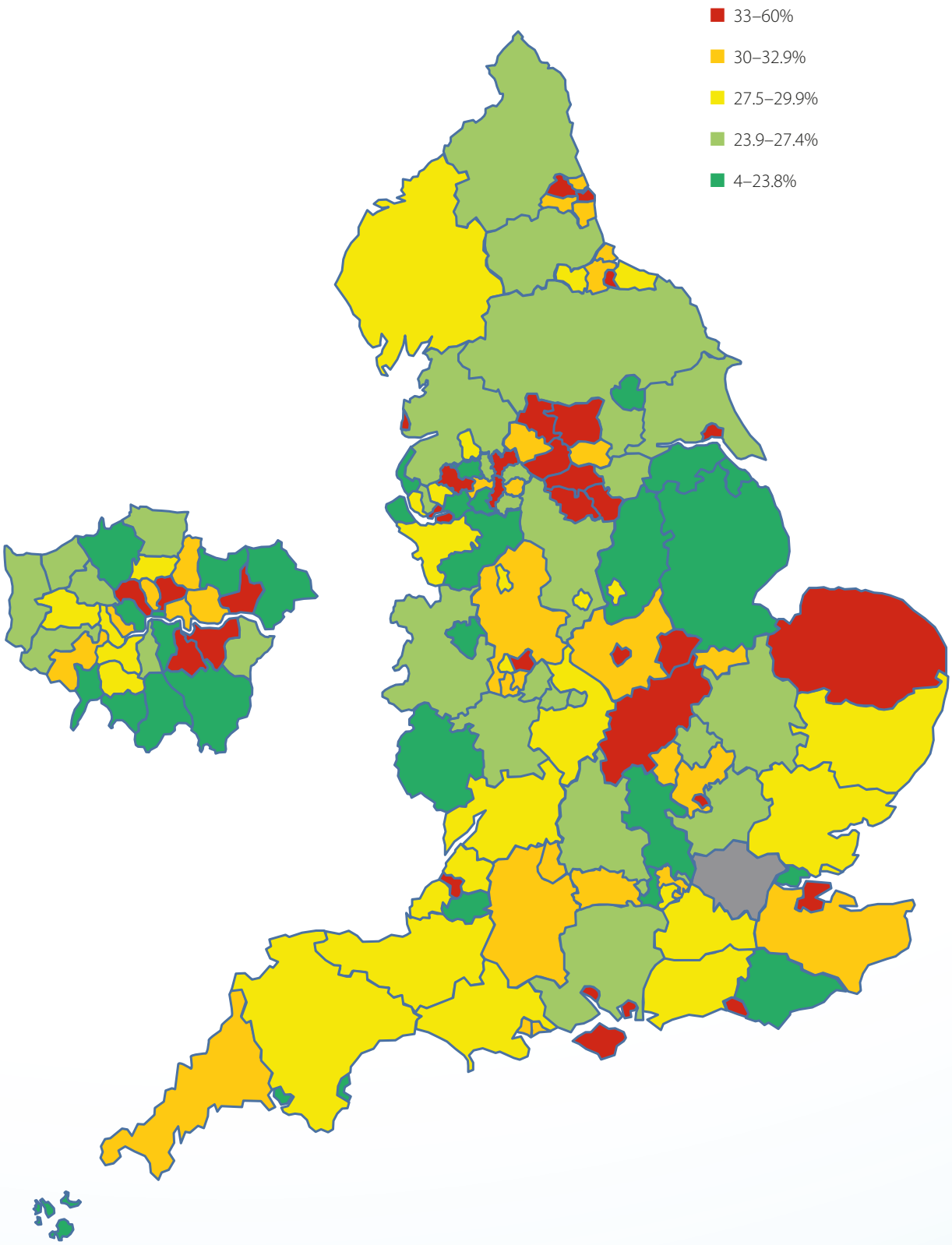


FIGURE B8A: Proportion of pupils who *did not achieve* A*–C in mathematics GCSE at Key Stage 4 across the 41 sub-regions of England in 2010

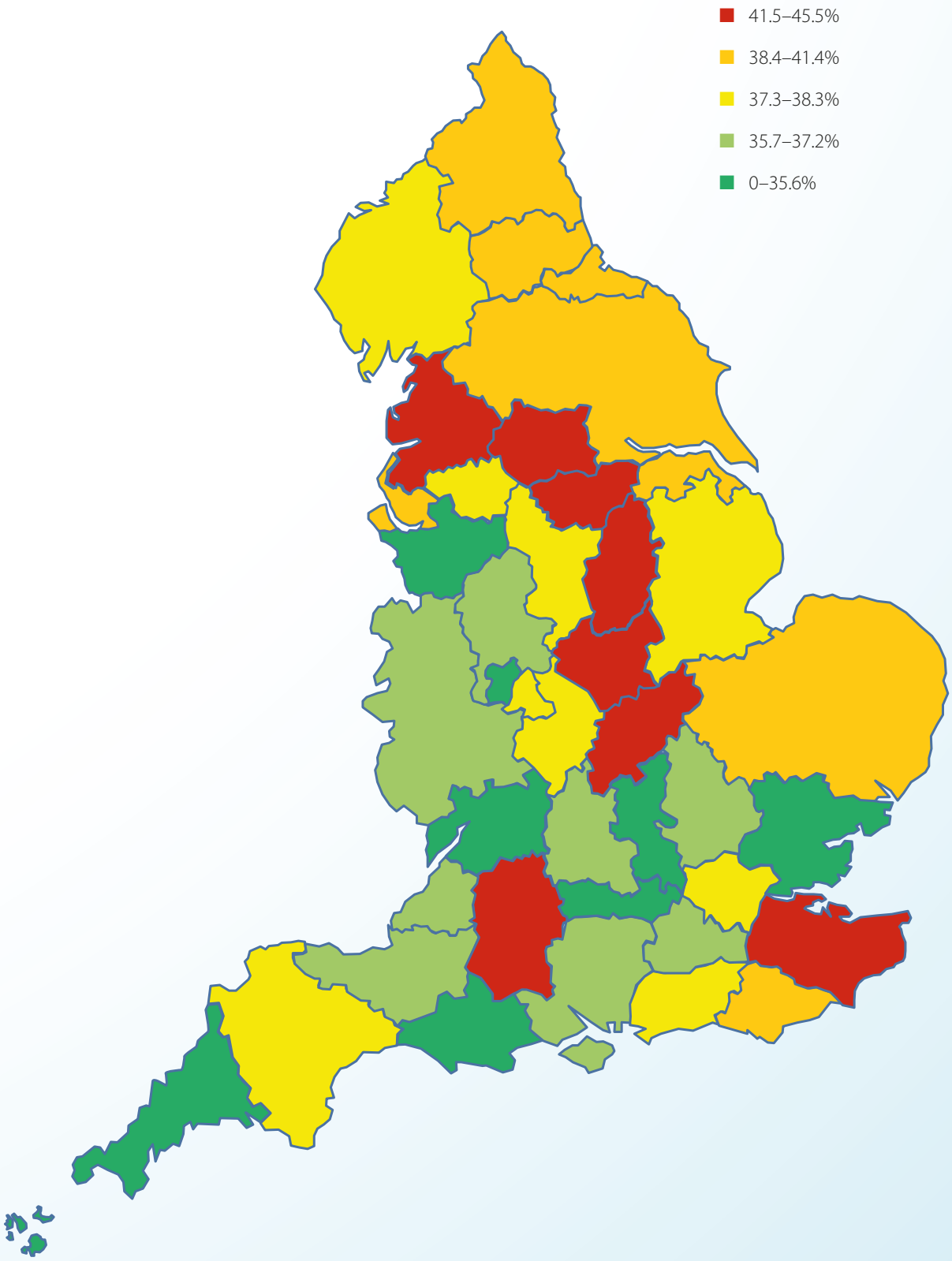
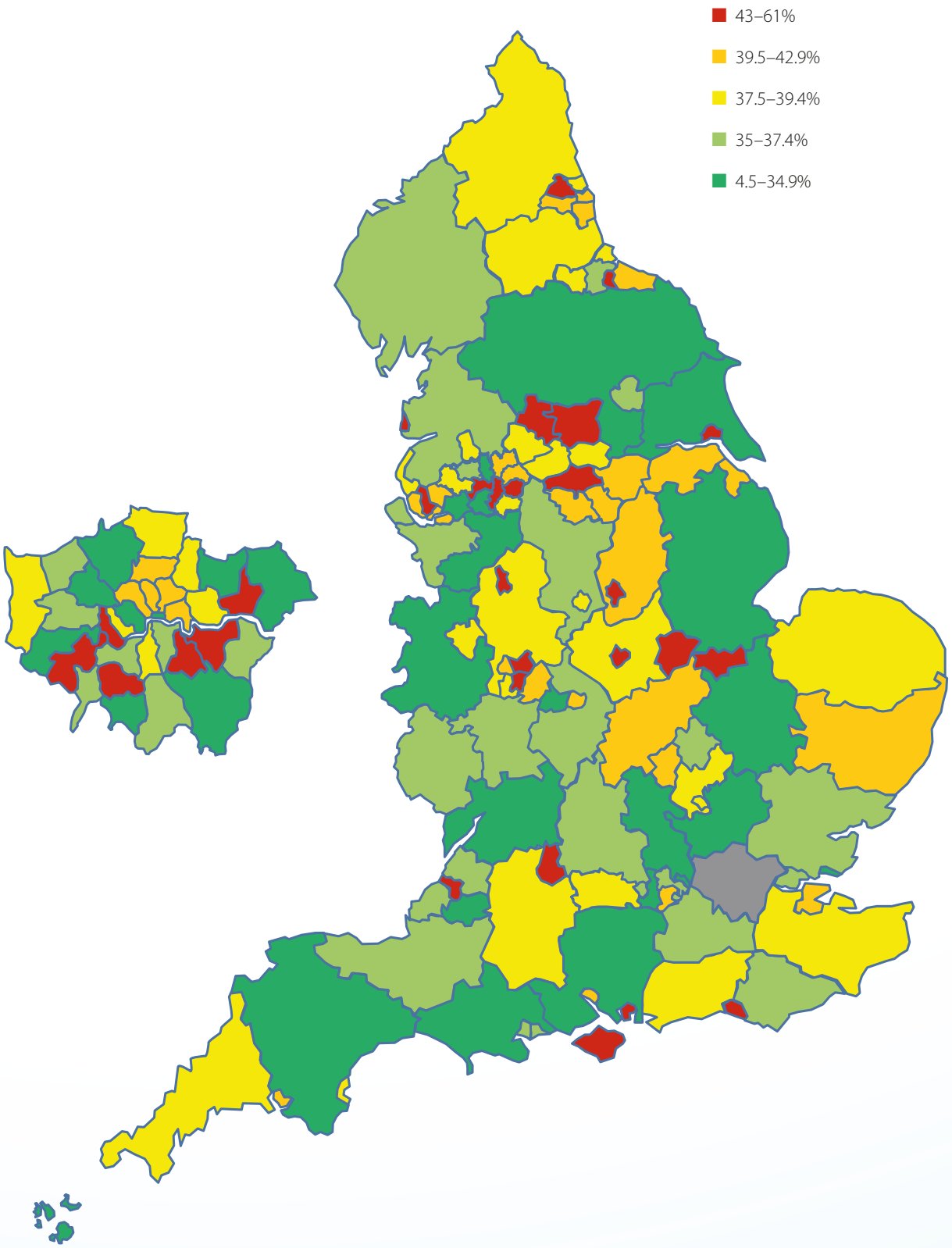


FIGURE B8B: Proportion of pupils who did not achieve A*–C in mathematics GCSE at Key Stage 4 across the 152 Local Authorities of England in 2010



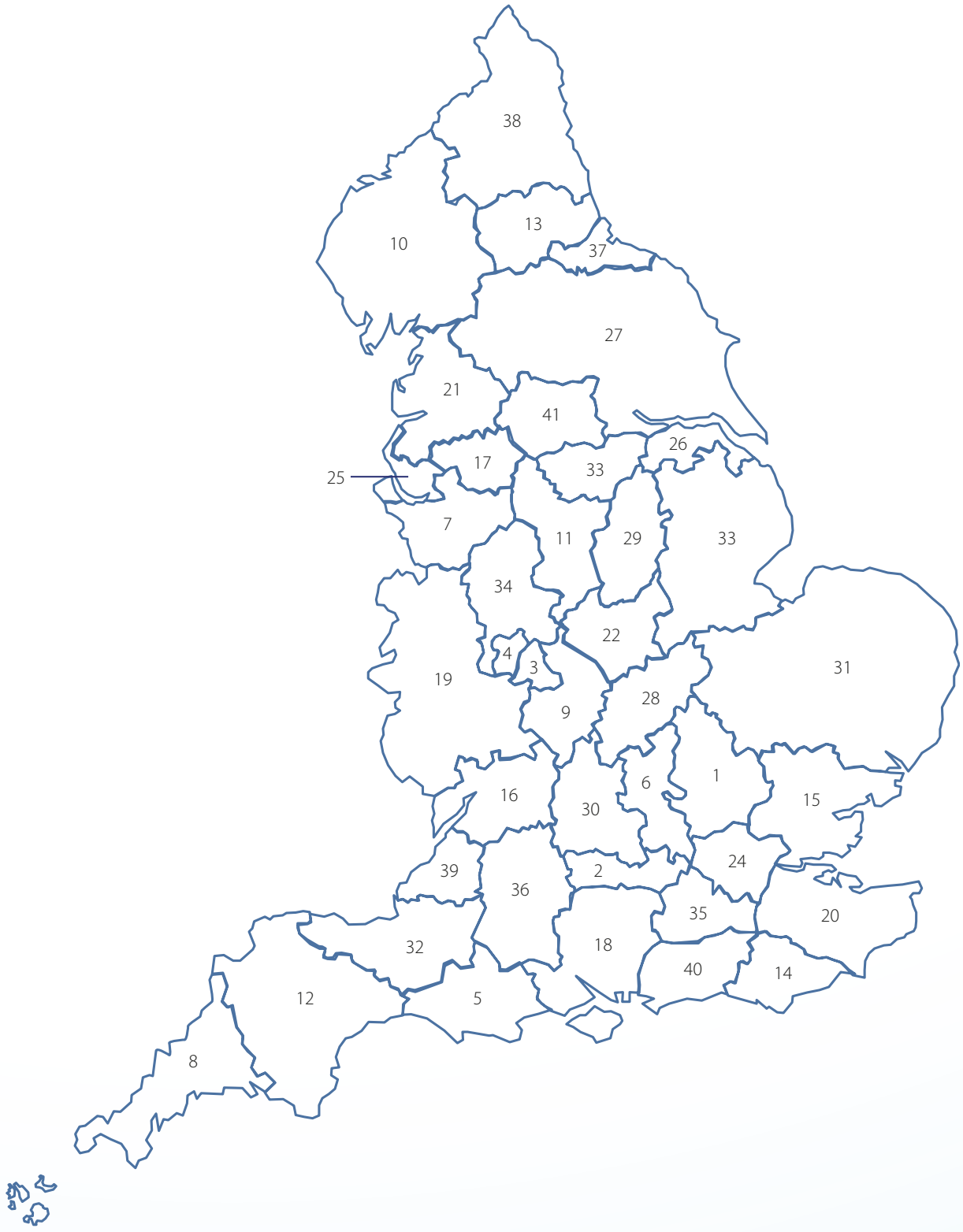
Annex C

Key to the sub-regions and local authorities in England

Key to sub-regions

Area	Region	Area	Region
1	Bedford Borough Central Bedfordshire Hertfordshire & Luton	22	Leicestershire
2	Berkshire	23	Lincolnshire and Rutland
3	Birmingham and Solihull	24	London
4	Black Country	25	Merseyside
5	Bournemouth Dorset Poole	26	NE and N Lincolnshire
6	Buckinghamshire	27	North and East Yorkshire
7	Cheshire	28	Northamptonshire
8	Cornwall and Isles of Scilly	29	Nottinghamshire
9	Coventry and Warwickshire	30	Oxfordshire
10	Cumbria	31	Peterborough Cambridgeshire Norfolk and Suffolk
11	Derbyshire	32	Somerset
12	Devon Plymouth Torbay	33	South Yorkshire
13	Durham	34	Staffordshire and Stoke
14	East Sussex	35	Surrey
15	Essex Southend-on-Sea and Thurrock	36	Swindon and Wiltshire
16	Gloucestershire	37	Tees Valley
17	Greater Manchester	38	Tyne Wear and Northumberland
18	Hampshire and Isle of Wight	39	West of England
19	Herefordshire Worcestershire Shropshire Telford & Wrekin	40	West Sussex
20	Kent and Medway	41	West Yorkshire
21	Lancashire		

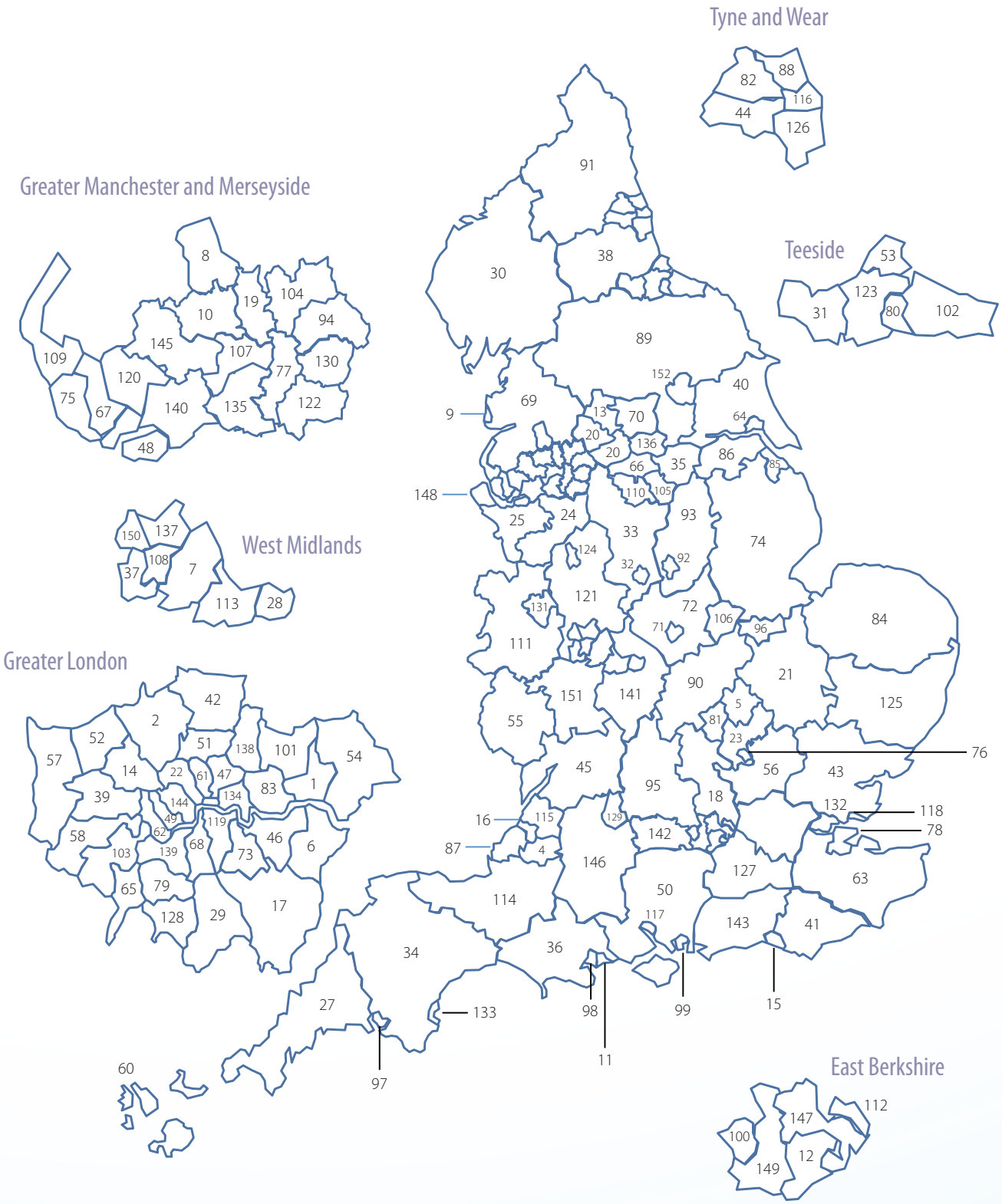
FIGURE C1: Key to the 41 sub-regions of England



Key to Local Authorities

Area	Local Authority	Area	Local Authority	Area	Local Authority
1	Barking and Dagenham	52	Harrow	103	Richmond upon Thames
2	Barnet	53	Hartlepool	104	Rochdale
3	Barnsley	54	Havering	105	Rotherham
4	Bath and North East Somerset	55	Herefordshire	106	Rutland
5	Bedford	56	Hertfordshire	107	Salford
6	Bexley	57	Hillingdon	108	Sandwell
7	Birmingham	58	Hounslow	109	Sefton
8	Blackburn with Darwen	59	Isle of Wight	110	Sheffield
9	Blackpool	60	Isles of Scilly	111	Shropshire
10	Bolton	61	Islington	112	Slough
11	Bournemouth	62	Kensington and Chelsea	113	Solihull
12	Bracknell Forest	63	Kent	114	Somerset
13	Bradford	64	Kingston upon Hull	115	South Gloucestershire
14	Brent	65	Kingston upon Thames	116	South Tyneside
15	Brighton and Hove	66	Kirklees	117	Southampton
16	Bristol	67	Knowsley	118	Southend-on-Sea
17	Bromley	68	Lambeth	119	Southwark
18	Buckinghamshire	69	Lancashire	120	St. Helens
19	Bury	70	Leeds	121	Staffordshire
20	Calderdale	71	Leicester	122	Stockport
21	Cambridgeshire	72	Leicestershire	123	Stockton-on-Tees
22	Camden	73	Lewisham	124	Stoke-on-Trent
23	Central Bedfordshire	74	Lincolnshire	125	Suffolk
24	Cheshire East	75	Liverpool	126	Sunderland
25	Cheshire West and Chester	76	Luton	127	Surrey
26	City of London	77	Manchester	128	Sutton
27	Cornwall	78	Medway	129	Swindon
28	Coventry	79	Merton	130	Tameside
29	Croydon	80	Middlesbrough	131	Telford and Wrekin
30	Cumbria	81	Milton Keynes	132	Thurrock
31	Darlington	82	Newcastle upon Tyne	133	Torbay
32	Derby	83	Newham	134	Tower Hamlets
33	Derbyshire	84	Norfolk	135	Trafford
34	Devon	85	North East Lincolnshire	136	Wakefield
35	Doncaster	86	North Lincolnshire	137	Walsall
36	Dorset	87	North Somerset	138	Waltham Forest
37	Dudley	88	North Tyneside	139	Wandsworth
38	Durham	89	North Yorkshire	140	Warrington
39	Ealing	90	Northamptonshire	141	Warwickshire
40	East Riding of Yorkshire	91	Northumberland	142	West Berkshire
41	East Sussex	92	Nottingham	143	West Sussex
42	Enfield	93	Nottinghamshire	144	Westminster
43	Essex	94	Oldham	145	Wigan
44	Gateshead	95	Oxfordshire	146	Wiltshire
45	Gloucestershire	96	Peterborough	147	Windsor and Maidenhead
46	Greenwich	97	Plymouth	148	Wirral
47	Hackney	98	Poole	149	Wokingham
48	Halton	99	Portsmouth	150	Wolverhampton
49	Hammersmith and Fulham	100	Reading	151	Worcestershire
50	Hampshire	101	Redbridge	152	York
51	Haringey	102	Redcar and Cleveland		

FIGURE C2: Key to the 152 Local Authorities of England



Annex D

Notes on the data

The data used are from the NPD for 2009/10 for England. These data are at learner level. Therefore all figures are numbers of pupils not numbers of qualifications.

These data do not describe qualification attainment directly but through derived variables at learner level, e.g. total number of qualifications the pupil has been entered for. While data at this level of aggregation makes it easier to analyse learner performance, the risk is that are qualifications entered or achieved by the individual are counted. It also complicates the analysis of qualification achievement as any specific qualification, combinations of qualifications not already described has to have a new learner level variables constructed and then tested and validated.

For the analysis of Science attainment at the end of Key Stage 4 a large number of new measures had to be constructed, these are described below. Unless the measure starts 'KS4_' or ends '_SPR10', the measure has had to be derived for this analysis.

Not all entries or achievements are regarded as valid in terms of national reporting or statistical analysis. Therefore, the DfE develop and apply various filters. As the current analysis aims to be as inclusive as possible a new filter has been developed: NUMRES_NAT.

This filter uses most of the selection criteria of the department, but includes independent schools, pupil referral units, and hospital schools, for anyone who is at the end of Key Stage 4, and on the role of an institution. The filter excludes 17,816 pupils out of a total cohort of 651,309.

The derived measure of Science and Mathematics attainment have been developed to be cumulative mutually exclusive. Starting with the highest level of attainment, the next measure describes only those pupils who did not achieve the highest level. For example, the majority of learners achieving physics GCSEs are captured in the first Science measure: Three Sciences at A*–C. Only those who did not achieve physics GCSE as part of 3 sciences are included in the measure Physics plus at least one other science GCSE. The advantage of this approach is that the measures sum to the total population, without any double counting.

It was found on a number of occasions that the DfE derived measures did not describe the complete set of learners the analysis is interested in. Therefore a large number of sub measures had to be developed to ensure these 'missing' pupils were captured. This means the figures will not exactly match those in the SFR. As the analysis is to examine the potential for progression, for those pupils who did not achieve 2 or GCSE in Science subjects, achievement in Engineering has been counted specifically, achievement in BTEC First Certificates and Diplomas in Engineering is regarded as equivalent to achievement in BTEC First Certificates and Diplomas in Applied Science for progression in engineering.

For each level of attainment in science, it was found that there were pupils who had achieved the level of attainment with a GCSE in Mathematics at A*–C and those who had not achieved Mathematics as A*–C. Therefore to describe the total population, dual measures had to be constructed. This approach coupled with the use of cumulative mutually exclusive measures of science achievement, make the derivation of measures of numbers of entries less useful and difficult to interpret.

All measures are in GCSE equivalents to determine if the 2A*–C has been reached

Annex E

About E4E

Education for Engineering (E4E) is the body through which the engineering profession offers coordinated advice on education & skills policy to UK Government and the devolved Assemblies. It deals with all aspects of learning that underpin engineering. It is hosted by The Royal Academy of Engineering with membership drawn from the professional engineering community including all 36 Professional Engineering Institutions, Engineering Council and EngineeringUK.

A full list of E4E member organisations can be found at www.educationforengineering.org.uk

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OPPORTUNITY OR ABILITY?

Key Stage 4 science and mathematics participation and attainment in England 2010