The Royal Society's response to the Curriculum and Assessment Review call for evidence

November 2024

The Royal Society welcomes the opportunity to contribute to the Curriculum and Assessment Review, which seeks to break down barriers to opportunity, deliver better life chances and enable more young people to succeed.

The Royal Society is a Fellowship of many of the world's most eminent scientists and is the oldest scientific academy in the world. The Society's fundamental purpose is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's corporate strategic priorities are to promote excellence in science; to support international collaboration; and to demonstrate the importance of science to everyone. It is for these reasons that the Society has a long-established education policy programme to ensure that the UK maintains its status as a world-leading scientific nation, to encourage science, maths and computing education to 18, and to generate evidence and analysis to support a range of public policy decisions.

Contents

1. Executive summary
2. Recommendations
3. Ambition for future system reform
4. Mathematical and data education
5. Science education
6. Technical and Further Education
7. Computing education
8. Assessment

1. Executive summary

1.1. The Royal Society believes that while there are current challenges for our education system that require immediate attention, the review must also advocate for more ambitious structural reform to support the new government's missions of kickstarting economic growth and breaking down barriers to opportunity, ensuring that every young person has the best possible opportunity to thrive. We welcome the government's commitment to reviewing education as an early priority in its programme, but it is our view that this initial call for evidence lacks the required vision. We would encourage the government and the independent Curriculum and Assessment Review Group to look beyond the 'here and now' and resist the temptation to make only small or easy changes to the system whilst leaving the rest of it unchanged.

1.2. We believe that a review that seeks to bring about significant change in the education system needs to be rooted in a set of guiding principles. These principles should both direct the long-term ambition of reform and help to achieve short-term improvements. They should also look beyond curriculum and assessment and provide a compelling vision for the future. The Royal Society believes that the Review Group should seek to develop such principles to steer the longer-term recommendations and implementation of any outcomes of the review.

1.3. On the basis that the implementation and outcome of recommendations will take time, the Royal Society would encourage the government and the independent Curriculum and Assessment Review Group to look beyond a single parliamentary term and consider what could be achieved with a longer-term review. As the Society has previously advocated, a review of the education system should resist the temptation simply to fix current challenges but instead have as its starting point a set of questions around the purpose and nature of the education system. In this way, the review could instead seek to address some of the fundamental questions around education, including what is its purpose, and what do young people need to know and do?

1.4. It is the Royal Society's view that ambitious reform can be achieved through incremental steps. The Review Group should make recommendations to government based on changes that could relatively easily be enacted now, that would simultaneously contribute to achieving a greater vision for an education system fit for the future. Addressing issues such as GCSE Mathematics and English resit policy, Core Maths provision or re-introduction of a version of AS level qualifications are relatively simple policy changes that could, for example, broaden the post-16 curricular offer and at the same time pave the way for more far-reaching changes.

1.5. Earlier this year the Royal Society's Advisory Committee on Mathematics Education and the Mathematical Futures Programme Board published *A new approach to mathematical and data education*[1]. This future-facing document outlines a transformative vision for mathematical education and highlights how such changes could help shape wider education system reforms. Central to this vision is a commitment to equip every teacher to integrate relevant mathematics and data into their practice. The report also advocates for innovative assessment methods that provide meaningful feedback on both understanding and performance, while at the same time ensuring that mathematical education is accessible and appropriately challenging at every stage for every pupil.

1.6. The role of the teaching profession is pivotal to the education system and consequently the success of any reforms arising from this review. The Royal Society is keen to ensure that the teaching workforce and representative professional organisations are intrinsically involved in the review process, the creation of new curriculum content and assessment, and subsequent implementation. It is the Royal Society's view that teachers should feel they are 'co-creators' of reforms to curriculum and assessment. In turn, this relies on ensuring that the framing of the review highlights the vital role of teachers in implementing its recommendations, including addressing possible concerns around matters such as additional workload, accountability and access to professional development.

1.7. For assessment, the Royal Society believes that it is important to assess individual progress and potential alongside the provision of national data, although we would urge the review group to begin with fundamental questions around what young people need to know and be able to do by the time they leave school or college, and what should be

[1] The Royal Society. https://royalsociety.org/-/media/policy/projects/maths-futures/mathematical-and-data-education-policy-report.pdf

measured and for what purpose. The exam system in its current guise is a longstanding feature of the education system, but its longevity does not mean that the way it operates has been successful for all students. The Times Education Commission identified it as one of several obstacles to change: "The entrenched nature of the current exam-focused system may resist changes towards continuous evaluation methods”[2].

1.8. Funding for subject specific professional development in biology, chemistry and computer science was significantly cut by the previous government, and a reversal looks unlikely in the short-to-medium term[3]. The Society previously made a strong case for an uplift in funding subject specific professional development across the sciences – this has been shown to have a positive effect on student outcomes through retention of experienced STEM teachers within the classroom and consequently contribute to wider economic growth[4]. The Royal Society continues to maintain that confident, experienced and up-to-date specialist science teachers are more likely to inspire students to pursue STEM study, research opportunities and technical career paths. Though current budget limitations may prevent the level of funding previously sought, the successful implementation of the review recommendations will be reliant on retaining talented teachers to steward the new curricula, and we would seek at least a return to the previous levels of CPD funding.

1.9. We commend the Government’s ambition for the future of the UK through its clearly stated ‘missions’. With education and skills provision as a core part of UK national infrastructure, the Royal Society would wish to see the issues raised by the review addressed across government departments and with support across the political spectrum. There are few areas of policy that would not benefit from ensuring the education system meets future need – for example, in breaking down barriers to opportunity, including the uneven representation of women, individuals from disadvantaged backgrounds and young people from some ethnic communities progressing to level 3 qualifications[5]. Interventions and strategies that tackle disadvantage at a fundamental level alongside curricular and assessment reforms will lead to greater improved outcomes for all students and unleash a wider talent pool to support growth.

1.10. Challenges around climate change and biodiversity loss will circumscribe the lives of current and future generations. To be prepared, young people will not only need to know the causes and possible remedies to these existential challenges, but also be able to engage with the complexities where science, policy and human decision-making overlap. The Royal Society has identified climate change, biodiversity, and sustainability as key areas of priority for school education, and welcomed the previous government’s publication of the ‘Sustainability and Climate Change Strategy for

[2] Times Education Commission. https://www.thetimes.com/society/education/education-commission
[3] UK Parliament. https://questions-statements.parliament.uk/written-questions/detail/2024-10-24/hl1975
[4] The Royal Society. https://royalsociety.org/-/media/policy/publications/2022/2022-01-31-sci-uplift-dfe.pdf
[5] IFS Deaton Review of Inequalities. https://ifs.org.uk/inequality/wp-content/uploads/2022/08/Education-inequalities.pdf

Education', which set out a vision for the UK to become "the world-leading education sector in sustainability and climate change by 2030"[6].

1.11. The Curriculum and Assessment Review provides an ideal opportunity to reform the education system ensuring that environmental sustainability topics are woven into the fabric of the curriculum, in line with the Government's previous support of the Climate Education Bill[7]. Specifically, this will be essential for the Review to deliver a curriculum that "ensures children and young people leave compulsory education ready for life and ready for work", and "reflects the issues and diversities of our society". However, the importance of these existential challenges necessitates action beyond just the curriculum and the assessment system, instead requiring an embedded approach to climate, sustainability and biodiversity education right across the system[8]. This would incorporate teacher professional development, the school estate, opportunities for student-led research projects, and links with employers and researchers working in relevant sectors.

[6] Department for Education. *Sustainability and climate change strategy*. https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy

[7] UK Parliament. *Climate Education Bill*. https://bills.parliament.uk/bills/3070

[8] University College London. www.ucl.ac.uk/ioe/departments-and-centres/centres/ucl-centre-climate-change-and-sustainability-education

2. Recommendations

2.1. **The Royal Society strongly recommends that, in addition to addressing immediate and urgent challenges, the Review Group and government commit to a systemic, longer-term review extending beyond the current parliamentary term.** Such an approach is essential to deliver meaningful, lasting change that is required if the UK is to remain competitive and provide opportunity to every young person. Furthermore, it is important to establish a coordinated, cross-governmental strategy when formulating and implementing any policy changes resulting from the review. A fragmented approach risks undermining the effectiveness of reforms and their potential impact.

2.2. Science and other STEM school subjects play a critical role in a well-rounded education and in developing future scientific innovation. A strong STEM education will help to achieve the government's aims of securing the highest sustained growth in the G7, establish Britain as a clean energy superpower and build and produce an NHS fit for the future. **The Society therefore recommends the formation of an expert group made up of scientific, industrial, and pedagogical expertise to address current challenges in science education and curriculum.** These challenges include restructuring the science curriculum to provide a single universal and coherent science pathway at GCSE; the use of practical inquiry-based learning; and the incorporation of technical routes.

- As the national academy of science comprising many of the world's leading scientists within its Fellowship, the Royal Society would be keen to work with government to convene such a group, drawing on its close connections with other national academies, learned societies, educationalists, business and industry leaders and across government departments.

2.3. **The Society recommends that the Review Group adapts the principles set out by the Royal Society Advisory Committee on Mathematical Education in its flagship report *A new approach to mathematical and data education***[9] in planning the future provision of mathematical and data education to meet the needs of every young person. To achieve this, government will need to put in place a taskforce to consider how to implement these high-level principles proposed in the report.

2.4. **The Review Group should advocate an urgent need to replace GCSE resits in mathematics with an alternative curriculum and assessment model that aims to address the reasons why the existing qualification is not suited to a sizeable minority who are persistently failed by it.** This might include greater application of mathematics to real-world contexts or modularised study and assessment – addressing students' engagement in the subject and supporting those whose mathematical abilities are undermined by fear of the subject and anxiety.

2.5. **The Review Group should additionally advocate for the potential benefits of restoring the links between AS and A levels in its recommendations to**

[9] The Royal Society. https://royalsociety.org/-/media/policy/projects/maths-futures/mathematical-and-data-education-policy-report.pdf

government, to help reverse the decline in breadth at post-16 and positively contribute to the destination choices of the most disadvantaged students.

2.6. The Royal Society recommends that digital literacy is at the core of any reforms to the computing curriculum, in addition, as recommended by the British Computing Society, **the Royal Society supports the proposal that the Review provide appropriate pathways for both specialist study in computing, and for more applied routes.**

- Computing suffers from particularly poor representation throughout secondary education and beyond, and therefore the Review Group should seek to ensure that any changes made to the curriculum and assessment of the subject take into account the desire to increase the take-up of computing from those currently underrepresented.

2.7. **The Review Group should consider how knowledge and skills related to technical routes are embedded and prominent within primary and secondary education curriculum**. In addition, the Society recommends that further review of the course content and assessment methods currently used in T Level courses is carried out, and that the Review Group considers the negative impact inequitable funding has on post-16 provision.

3. Ambition for future system reform

3.1. The Royal Society has long advocated for educational reform[10], calling for a long-term review of the secondary education system to include, among other areas, meaningful methods of assessing and measuring progress for young people. A reformed education system which prioritises interdisciplinary knowledge and skills and assesses students using a range of methods which serve to measure progress and recognise achievement, would help to develop the crucial real-world skills necessary to open opportunities to young people, and to contribute to necessary economic growth.

3.2. Many reforms which would lead to a truly transformed education system – one that prioritises breadth of study, drastically reduces the emphasis on high stakes terminal assessment, and where teachers are valued, trusted and supported with the ability to teach creatively, look to be beyond the scope of the terms of reference for this review. We recognise that the review must have a focused scope, but we would urge the Review Group and the Government to consider that if our goal is an education system that prepares young people for the future, making minor adjustments to the current curriculum and assessment system alone will not solve the challenges we currently face.

3.3. The skills base of a population is foundational to economic growth and success and therefore without growing that skills base we have little hope of improving economic sustainability as a nation. In this way, the education and skills sector should be one of the priority policy areas for government thinking about how to improve productivity. The current system will not meet the demands of the next 50 years[11]. In an essay for the Royal Society's *Envision* publication in 2022, Andy Haldane FRS, Chief Executive of the Royal Society of Arts and former Bank of England Chief Economist, states:

> "Productivity is a means to an end. It gives us the means to shape society in the ways we want, including by supporting individuals and protecting the planet. We are on the cusp of another transformative era. Unlocking the productivity potential of this new era will call for institutional as well as innovative transformation. There are few better places to start than with our education system."

3.4. Evidence exists that, in addition to greater preparedness for a fulfilling life, a broader education increases employability and earnings. A 2021 Royal Society study carried out by the Education Policy Institute (EPI) drew on Department for Education Longitudinal Education Outcomes data to consider the relationship between breadth of study and employment outcomes[12]. A troubling finding was that post-16 breadth had sharply

---

[10] For example: The Royal Society. https://royalsociety.org/news-resources/projects/vision/; The Royal Society. https://royalsociety.org/news/2019/02/call-for-independent-review-of-post-16-education/; The Royal Society.

[11] The Royal Society. https://royalsociety.org/-/media/policy/projects/envision/andy-haldane--better-education-better-productivity-envision.pdf

[12] The Royal Society and EPI. https://royalsociety.org/-/media/news/2021/epi-royal_society-16-19-report.pdf

declined, with a 14-percentage point fall in the number of students taking qualifications from three or more subject groupings. This decline appeared to be driven by reductions in the number of qualifications taken because of the decoupling of AS and A levels in 2015. Significantly, there was a link between breadth, attainment, and more advantaged students: those with higher GCSE mathematics and English grades and lower levels of disadvantage were more likely to study a broader range of subjects at A level. A 2024 study by the British Academy and NFER saw further narrowing of subject choices at A level, again partly attributed to the decoupling of AS and A level qualifications[13].

3.5. The knock-on effect of this lack of breadth is apparent in earnings at least in the early career stage – even after controlling for background and educational achievement, those who studied a broader range of subjects at post-16 had earnings equal to three to four per cent more than those taking subjects from only one subject grouping. The research authors recommended that 'the government must act to ensure that England's already uniquely narrow 16-19 provision is not squeezed further still.' Since the report's publication, narrowness at post-16 has grown more pronounced. Where the average number of A levels taken in 2019 was 2.7 per person, in 2023 that had fallen to 2.65, further narrowing both choices and opportunities for young people.

3.6. The decoupling of AS levels from A levels has been cited as one reason for a marked decline in breadth of study – a fall of 43% between 2016 and 2019[14]. AS levels were seen to have significant educational benefit from many across the education sector, allowing students to understand their progress and to refine their progression options, such as applying to universities with different entry requirements according to their AS level results[15]. The Review Group should carefully consider the potential benefits of restoring the links between AS and A levels in its recommendations to government.

3.7. Concerns about the inflexibility and restriction that the English Baccalaureate (EBacc) places on student choice are widespread and well documented. In 2023 the House of Lords' Education 11-16 Year Olds Committee recommended that government should abandon the requirement for 90% of pupils in state-funded education to take the EBacc subject combination, as well as advocating withdrawal of the EBacc subject categorisation and the EBacc average point score accountability measure[16]. Though rejected by the previous government, the Royal Society strongly suggests the Review Group revisits this report within its consideration for the future of the curriculum and assessment systems.

3.8. Government data for England shows teachers are leaving the profession in record numbers and that too few new recruits are joining it[17]. In many secondary subjects,

---

[13] The British Academy. https://www.thebritishacademy.ac.uk/publications/subject-choice-trends-post-16-education-england/

[14] The Royal Society and EPI. https://epi.org.uk/wp-content/uploads/2021/09/EPI-Royal_Society-16-19-report.pdf

[15] University of Cambridge. https://www.undergraduate.study.cam.ac.uk/sites/www.undergraduate.study.cam.ac.uk/files/publications/letter_to_schools_and_colleges_wales.pdf

[16] Education for 11–16 Year Olds Committee. https://publications.parliament.uk/pa/ld5804/ldselect/ldedu1116/17/1702.htm

[17] NFER. https://www.nfer.ac.uk/publications/teacher-labour-market-in-england-annual-report-2023/

there is an increasing reliance on non-subject-specialist teachers to take lessons[18]. Anecdotally, some secondary school mathematics, computing and science departments now have no recognised subject specialists[19].

3.9. Teacher recruitment and retention has been a persistent challenge for decades. The Royal Society commends the Government's plan to recruit an additional 6,500 teachers, but recommends producing a compelling vision that, with teachers' buy-in, resets the teaching profession and focuses on retention of teachers, in tandem with reviewing the curriculum system and its assessment. This vision needs to recognise teachers' value and agency by restoring to them the professional autonomy and responsibility they appear to have lost. This may include:

- considerations such as greater trust in how teachers teach and assess students;
- new accountability measures that value developing the analytical, problem solving, critical thinking and creative capabilities employers increasingly need alongside knowledge acquisition[20];
- embracing AI and other digital technologies so that, for instance, teachers can potentially provide for the specific learning needs of individual students, or work more flexibly, and so that students know how to use these tools properly and about their limitations;
- reinstating subject-specific knowledge as an essential focus within initial teacher education and throughout teachers' professional careers;
- a commitment to a model of sustainable funding for providing high-quality professional development on the understanding that this may require absence from the classroom.

3.10. In this new system, teachers would be enabled to become what Andreas Schleicher, Director for Education and Skills at the Organisation for Economic Co-operation and Development (OECD), has called 'active agents of their own professional growth'[21], free to teach innovatively, and trusted as the principal reformers of education in schools and colleges. Teachers would be more responsible for interpreting the curriculum and for driving their own professional development, an essential requirement for a teaching career.

---

[18] Schools Week. https://schoolsweek.co.uk/extent-of-classes-taught-by-non-specialist-teachers-revealed/

[19] The National College. https://www.schoolbus.co.uk/news/featured-article/number-of-teachers-leaving-the-profession-hits-record-high/9649

[20] NFER. https://www.nfer.ac.uk/key-topics-expertise/education-to-employment/the-skills-imperative-2035/

[21] OECD. https://www.oecd-ilibrary.org/matching-teacher-demand-and-supply_5k97jf7cgmxq.pdf

4. Mathematical and data education

4.1. We live in a world that is dominated by data and where lacking numeracy skills stifles opportunity. Improving mathematical and data education at every stage in a child's learning journey from early years through to school or college-leaving is therefore one of the most profound changes that could be enacted by the Curriculum and Assessment Review to equip young people to thrive in our rapidly changing societal and technological landscape. Multiple sources of evidence demonstrate that the current system fails to provide this education for the majority.

4.2. A system change introducing a more diverse and equitable model for mathematics education is critical to breaking down barriers to opportunity. It is for these reasons that in 2020 the Royal Society established the Mathematical Futures Programme, which published its final report in September 2024. The reforms suggested by the Royal Society in the report are not intended to be easy and quick wins, nor do they focus solely on curriculum content but set out a series of principles and recommendations informed by evidence from several commissioned research studies. These proposed changes cannot be developed by limited short-term measures; they will take 10-15 years to implement fully and will need planned and coordinated progress on four fronts; curriculum, qualifications and assessment, resources, and professional development. They will need careful planning, design, implementation and evaluation – as well as significant investment. They will require collaboration between all stakeholders involved, cross-party support, and determination to stay the course. At the same time, we recognise that adopting the review group's approach around evolution, there are short-term opportunities at every step along the way.

4.3. While mathematics education in the UK has made progress in recent decades, it still lets too many students down. Despite the considerable emphasis placed on mathematics, long-standing inequalities persist between the lowest and highest achievers, and between cohorts depending upon their gender, social backgrounds, and SEND status. To address these inequities, it is critical to address the nature of mathematical education: its relevance, inclusivity, flexibility, and responsiveness to today's digital society.

4.4. The Royal Society's report 'A new approach to mathematical and data education' sets out in detail the need for change and potential solutions which could be implemented over the longer term, beginning with feasible steps in the shorter term. We recommend that this report is considered in full by the Review Group as part of The Society's evidence. The points that follow are based on evidence contained in the report.

4.5. The Royal Society proposes a move to a wider definition of mathematical education: mathematical and data education (MDE)[22]. MDE incorporates 'maths' but extends to teaching young people to think mathematically, apply mathematical techniques to real world contexts and to better understand how and why maths is valuable in other subject domains. MDE is a critical component of our wider vision of a broad and balanced curriculum, and plays a crucial role in preparing students to meet the increasingly quantitative demands of the workplace and further study.

4.6. Mathematical and data education has three interlinked components. All young people should leave school or college with a grounding in each, but many will have attained higher levels in one or more element depending on the pathway they follow:

[22] The Royal Society. royalsociety.org/-/media/policy/projects/maths-futures/mathematical-and-data-education-policy-report.pdf.

- Further and Advanced Mathematics (FAM): an evolution of the current mathematics curriculum, with a greater emphasis on data and the use of computational skills. This will establish essential capabilities for further mathematical study and learning more generally, incorporating the understanding of fundamental mathematical ideas and the development of more complex mathematical and data techniques.
- General Quantitative Literacy (GQL) addresses the growing and currently unmet need for all students to confidently apply their mathematical and data skills to the common, real-world, quantitative problems they will face in a range of educational, employment and everyday contexts. GQL is essential for operating effectively in daily life, citizenship and work; it underpins the ability to critically interpret arguments that are based on mathematics and data
- Domain-Specific Competencies (DSC) describe those mathematical and data skills that are increasingly acquired and used outside of the mathematics classroom, whether in jobs or other subject disciplines. Domain-specific competencies would be authentically embedded within other subjects and would enable learners to apply mathematical and data skills in other areas, from estimations in construction to sampling in biological fieldwork.

4.7. If everyone left school with the level of mathematical and data understanding we aspire to, there would be immeasurable benefits for society, innovation, for the economy and for individual flourishing. The demand for mathematical skills is increasing: between 2019 to 2023, jobs requiring A-level maths skills grew by an average of 8.5% per annum[23]. This year, the Academy for Mathematical Sciences estimated that 4.2 million people (13% of those in employment in the UK) were working in jobs that use tools or techniques derived from the mathematical sciences, generating £495 billion in gross value added per year. These workers earn 24% more than the UK average and were 58% more productive[24].

4.8. Adult numeracy is fundamental to modern life. All citizens need quantitative skills to manage their daily lives, evaluate numerical claims, contribute to civic society, and to increase and embrace the opportunities available to them. These skills will be an engine of change for tackling persistent inequalities and can re-animate the productivity growth needed for economic renewal. At present, however, mathematical education leaves too many behind. According to a 2022 YouGov survey, 54% of the UK's working-age population has low numeracy, with 45% of respondents demonstrating a level equivalent to that expected of children when they leave primary school[25]. Low numeracy has been estimated to cost the UK economy around £25 billion per year, and decisions linked to poor numeracy are estimated to cost the average individual £460 per annum[26]. As of 2021, 16 million workers with low numeracy were estimated to earn an average of £1,600 less per year than they would with a basic level of numeracy[27].

---

[23] The Maths Summit. https://www.themathssummit.co.uk/_files/ugd/21ee65_75559efc6f784027aac6984663512cab.pdf.

[24] Academy for the Mathematical Sciences. https://www.acadmathsci.org.uk/wp-content/uploads/2024/10/AcadMathSci-22Oct2024-Economic-Contribution-MathSci.pdf.

[25] National Numeracy. https://www.nationalnumeracy.org.uk/news/new-survey-uk-numeracy

[26] National Numeracy. https://www.nationalnumeracy.org.uk/news/counting-on-the-recovery

[27] National Numeracy. https://www.nationalnumeracy.org.uk/sites/default/files/documents/Counting-on-the-Recovery.pdf

Individuals with low numeracy are likely to have reduced earning potential and poorer health, with knock-on negative impacts on social wellbeing and economic prosperity.

4.9. Key action based on evidence from A new approach to mathematical and data education: The government should sponsor an independent task force to plan for long-term system changes and implement the recommendations from this report. This task force should include relevant government departments such as Department for Education, Department for Science, Innovation and Technology, Department for Business and Trade, and the Treasury. It should also involve senior figures from key stakeholder bodies and should consult with devolved nations. A sufficient budget should be provided to commission exploratory and developmental projects.

Curriculum:

- Design and implement a curriculum that integrates appropriate data, statistics, and computational tools coherently with mathematics.
- Review the early years and primary curriculum to provide strong foundations, strengthening key areas such as spatial reasoning

Assessment:

- Develop a single MDE qualifications framework which enables all students to continue to study MDE to 18. Design the framework around parallel and complementary foundational and advanced mathematics and general quantitative literacy strands, with recognition of domain-specific competences acquired in vocational and technical routes. Base the general quantitative literacy strand on development of the existing Core Maths qualifications.
- Develop a low-stakes competency assessment, to be taken by all students around the end of key stage 3 (age 14), to enable individual learners to demonstrate mastery of the foundational MDE concepts and skills necessary for confident and engaged citizenship.
- Develop assessment methods that identify and communicate what students know and can do.
- Develop new methods of assessment for general quantitative literacy that reflect how it is used in practice, including the use of digital technologies to analyse data sets.
- Standardise MDE terminology and level of detail expected in all school and college courses and require awarding organisations to be consistent in how they describe MDE competences in their programmes of study and assessment criteria. Begin this process by carrying out a study into how MDE competences are currently described and used in existing high-stakes qualifications in non-maths subjects.
- Develop digital assessment methods that can grow as needed, enabling the use of MDE-specific digital tools and benefitting from lower costs and improved operations.

Technology:

- Computational tools and technologies, such as spreadsheets, apps and programming platforms, should be well-embedded at suitable stages within MDE learning. Curriculum designers should ensure these technologies are incorporated to meet the new MDE objectives.

- Carry out a dedicated research programme on the potential impact of AI on MDE learning, identifying new approaches for students at all stages of their education.
- Strengthen the links between MDE and computing by: including problems in MDE that draw on pupils' computing knowledge and skills, including programming; and providing rich, motivating MDE contexts for programming and other skills in computing lessons.
- Ensure advanced MDE students (post-16) develop programming skills and learn the use of computational tools common in mathematically-demanding undergraduate programmes.

Teachers:

- Prioritise funding over several years to support a major programme of professional development, including initial teacher training, early career training and continuous professional development to support the implementation of MDE. This should be designed into the implementation plan from the outset and sustained over time.
- Develop professional development programmes, with supporting classroom resources, to enable current teachers to become expert teachers of MDE at key stage 3, and to encourage new routes into teaching.
- Develop ways for mathematics and subject departments in schools and colleges to work with each other to support consistency and coherence between subjects and phases in the teaching of MDE across all subjects; for example, by developing whole-school MDE curriculum guidance documents.

5. Science education

5.1. Science, mathematics, and computing are central to modern life, underpinning our understanding of the world and enabling solutions to global challenges such as climate change, misinformation, and the rise of artificial intelligence. A scientifically literate population is essential for navigating an increasingly technology-driven future. Science education must therefore ensure foundational scientific literacy for all while preparing those who wish to pursue advanced studies in these fields.

5.2. The Royal Society characterises the purpose of school science education as:

- Equipping young people with the technical expertise necessary for future economic growth and an increasingly technological world.
- Promoting scientific literacy, including developing critical appreciation of the cultural significance of science and its role as an integral component of the UK's heritage.
- To foster the wonder of science and drive curiosity so that all students can appreciate how the sciences have contributed to human achievement and culture.
- To have a foundational understanding of the scientific method and be able to apply key concepts through experimentation and the development of analytical skills.
- To understand how a science education can contribute to a vast array of fulfilling career pathways
- Equipping all students with the skills and knowledge necessary to engage critically with scientific issues in everyday life.

5.3. An updated science curriculum should include interdisciplinary learning, real-world applications, current scientific understanding and a greater emphasis on practical science, which will allow students to develop core knowledge and skills for science and beyond. It is particularly important that a reformed science curriculum allows students the opportunity to develop skills related to data and critical thinking, especially enabling them to evaluate scientific credibility and reliability.

5.4. Reforms to science education should consider how best to encourage more students from diverse backgrounds to pursue STEM study, training and careers. To achieve an excellent science education for all young people, we should seek to align ourselves with international benchmarks and learn from the best practices of other high-performing jurisdictions. The Royal Society recommends that an expert group be established to guide the necessary development and evaluation of science education, including but not limited to, curriculum and assessment.

5.5. In England, the science curriculum has largely focused on developing future scientists rather than fostering a citizenry equipped to engage critically and responsibly with scientific issues, including those that may directly affect their health and wellbeing. This has been the case for more than a quarter of a century. At the turn of the millennium, expert science educationists published the Beyond 2000 report which stated that even for those who 'succeed' with the current curriculum, the kind of 'understanding' they achieve does not equip them to deal effectively and confidently[28].

5.6. The flaws in England's existing science curriculum reflect a failure to move with the times. Regrettably, the critique offered by the Beyond 2000 report is equally relevant today:

[28] Nuffield Foundation. https://www.nuffieldfoundation.org/wp-content/uploads/2015/11/Beyond-2000.pdf

> "the current curriculum … [presents] science as a body of knowledge which is value-free, objective and detached – a succession of 'facts' to be learnt, with insufficient indication of any overarching coherence and a lack of contextual relevance to the future needs of young people."[29]

5.7. Indeed, the current content requirements of GCSE science are now so great that many schools have resorted to condensing key stage 3 and starting teaching key stage 4 science from year 9[30].

5.8. More recently, Ofsted's science subject report *Finding the Optimum* found that: "In a significant minority of schools visited, pupils were not developing secure knowledge of science", resulting in them "studying science, often for long periods of time, without developing sufficient substantive and disciplinary knowledge."[31]

5.9. There is genuine reason to be concerned that students are not gaining a solid conceptual foundation in science, with teachers often failing to check for or correct misconceptions and misunderstandings. While students may be able to successfully memorise and recall scientific 'facts', they may not fully understand, or may continue to have misconceptions about, what they have learned. In 2023, Ofsted reported that "we saw few examples of teachers proactively checking for specific misconceptions or misunderstandings. Some pupils therefore continued to hold unscientific ideas about the content they were learning."[32] This echoes the findings of the much earlier *Beyond 2000* report regarding the number of young people who lack familiarity with commonplace scientific ideas[33].

5.10. In addition to the clear issues posed by young people leaving education without a sufficient level of competence and confidence in core scientific concepts, other criticisms of the current curriculum include the failure, through the lack of timely monitoring and updating, to take account of new scientific understanding, the multi- and interdisciplinary nature of the sciences and changing (including cross-disciplinary) scientific research practices. Some clear examples that are under-accounted for within the curriculum are challenges such as environmental sustainability (a composite term that includes climate change, biodiversity and sustainability), and the need for all people to have the skills to be able to distinguish reliable from unreliable or malicious information on the internet that is presented as being 'scientific'.

5.11. Under the previous government, the Department for Education set out a vision for the UK to be "the world-leading education sector in sustainability and climate change by

[29] Nuffield Foundation. https://www.nuffieldfoundation.org/wp-content/uploads/2015/11/Beyond-2000.pdf

[30] Cramman, H., Kind, V., Lyth, A., Gray, H., Younger, K., Gemar, A., Eerola, P., Coe, R., & Kind, P. 2019. https://durham-repository.worktribe.com/output/1605305; Ofsted. https://www.gov.uk/government/publications/research-review-series-science/research-review-series-science

[31] Ofsted. https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2

[32] Ofsted. https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2

[33] Nuffield Foundation. https://www.nuffieldfoundation.org/wp-content/uploads/2015/11/Beyond-2000.pdf

2030."[34] However, as summarised in a report by the House of Lords Education for 11–16 Year Olds Committee, a number of teachers, students, and organisations expressed concerns that sustainability and environmental topics are not adequately covered within the curriculum and are confined within 'subject silos', and that teachers are not adequately prepared to teach this content[35]. Although the previous government's response to the report stated that "key elements on climate change are already covered in existing curricula"[36], we have searched the current national curriculum for key climate change and environmental terminology and found no reference in the statutory content to relevant and commonly used terms such as 'conservation', 'global warming', 'fossil fuels', 'green energy', 'nature', or 'sustainability'.

5.12. Concerns about student understanding are underscored by official data on entries and examination performance. The Review Panel's own data show that show that the majority (65%) of students at the end of KS4 who enter GCSE science exams take Combined Science[37], but attainment data show that between 2018 and 2024, the percentage of students in England being awarded grade 4 or higher (a passing grade) in Combined Science ('double-award') was consistently lower than 65.1%[38].

5.13. Further, there appears to be a misplaced complacency in attitudes toward uptake of the sciences post-16. For although biology, chemistry and physics are consistently ranked among the top ten most popular subjects taken at A level, the trends in the number of entries to each of these subjects do not show the sort of increases that might have been anticipated given growth in the size of school rolls and the increasing demand for STEM-skilled labour. The Review Panel's data show, respectively, that the percentage of all A level entries accounted for by biology, chemistry and physics have not increased substantially since 2009/10. Moreover, a recent study by Cambridge Assessment has shown that just 1% of students studying Combined Science go on to take A level physics and, equivalently, 2% and 4%, respectively, progress to A level chemistry and biology[39]. Arguably, if the GCSE science curriculum was really delivering, it is conceivable that far more young people would be motivated to study the sciences post-16.

---

[34] Department for Education. *Sustainability and climate change strategy. https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy/9317e6ed-6c80-4eb9-be6d-3fcb1f232f3a*

[35] Education for 11–16 Year Olds Committee. https://committees.parliament.uk/publications/42484/documents/211201/default/

[36] Department for Education. *Education for 11 to 16 year olds Government response to the report of the House of Lords Committee*. https://assets.publishing.service.gov.uk/media/65cf4a154239310011b7b8f8/CP1026_Education_for_11_to_16_Year_Olds_-_Government_response_to_the_House_of_Lords_report.pdf

[37] Department for Education. https://consult.education.gov.uk/curriculum-and-assessment-team/curriculum-and-assessment-review-call-for-evidence/supporting_documents/Curriculum%20subject%20trends%20over%20time.pdf

[38] FFT Education Datalab. https://results.ffteducationdatalab.org.uk/gcse/science-double-award.php?v=20230817

[39] Williamson, J. & Vidal Rodeiro, C.L. 2024. https://www.cambridgeassessment.org.uk/Images/707601-progression-from-gcse-to-a-level-2020-2022.pdf#:~:text=Figures%201a%20and%201b%20(single%20GCSEs)

5.14. But, as the 2023 Science Education Tracker (a nationally representative survey of 11–18 year old students attending state-funded secondary education in England) has shown, interest in school science declines markedly through early secondary education[40]. Students state that it can be difficult, that they do not find some topics interesting, that they don't do enough hands-on practical science, and that there's too much to remember. This contrasts with their appreciably greater interest in science outside school or through extracurricular activities such as undertaking project-based investigations.

5.15. The Science Education Tracker also indicates that declining interest in science is particularly marked among girls in years 7–9. The percentage of girls in this age group expressing they were 'very' or 'fairly' interested in science was just 65% compared to 75% in the 2019 survey, while the percentage of interested boys remained consistent at 77% in 2019 and 76% in 2023. A similar pattern of observations was recorded among year 10–13 students, with students being more negative about science subjects compared with 2019.

5.16. Experimentation and other practical work in science is integral to the practice of science, yet opportunities for students to engage in hands-on practical science have been declining over time. This reduction has been fuelled by a combination of recent curriculum and assessment reforms, the increasing shortages of specialist subject science teachers and technicians, and squeezes on school funding. The reduction has also accelerated because of the disruptive impacts of the pandemic on opportunities for teacher education and professional development[41]. As a result, hands-on practical science is becoming increasingly marginalised. The Science Education Tracker has shown that just 26% of GCSE students are engaging in hands-on practical work at least fortnightly (down from 44% in 2016) and that they are more likely to be asked to watch a video of a practical than to undertake hands-on practical work[42].

5.17. The Review Panel has been clear that changes to the curriculum should be made through evolution rather than revolution and, as recommended in 2.2 the Royal Society would like to see the establishment of an expert group tasked with developing a new interdisciplinary curriculum in the sciences, working to a timetable that allows ample time for consultation, development, research and evaluation: there is a poor track record in England of piloting initiatives.

5.18. The expert group should take into consideration the chronic shortages of both subject specialist science teachers (particularly in chemistry and physics) and science technicians. The development of a new sciences curriculum should happen alongside changes geared to strengthening the teaching workforce, including the establishment of a sustainable model for ensuring the continuing professional development needs of all science teachers and technicians are adequately provided for.

5.19. The development of the sciences curriculum should particularly take into consideration the design of curricula used by highly ranked international education systems, and the philosophy underpinning the OECD's 2025 PISA science tests, which

---

[40] The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

[41] Ofqual. https://www.gov.uk/government/publications/learning-during-the-pandemic/learning-during-the-pandemic-review-of-research-from-england; Oxford University Press. https://www.oup.com.au/__data/assets/pdf_file/0028/186832/The-evolution-of-science-education-Oxford-University-Press.pdf

[42] The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

measure “how well countries are preparing their students with an understanding of science and how science produces reliable knowledge.”[43]

5.20. In addition, revised science curricula should place a renewed emphasis on hands-on practical science, with its provision revitalised and recentred. The exam boards’ existing prescription for practical inquiry has scarcely changed since the National Curriculum was first introduced, but both scientific research practices and understandings of effective assessment have changed greatly.

5.21. Over recent decades several initiatives have developed within both formal and informal learning that set out to provide young people with a more authentic experience of science – providing opportunities to think and work like a scientist. Many initiatives involve research scientists and their research departments. Others draw on enthusiastic ambassadors from industry. The Royal Society believes that every student should have the opportunity to be involved in a piece of original STEM investigative practical work in school. Ongoing pilot projects, administered by the Royal Society and funded by the Department for Science, Innovation and Technology (DSIT), are showing how this can be done by building sustainable partnerships between schools, teachers, universities, employers and STEM professionals. These new partnerships, all built around original research projects, will introduce pupils and teachers to working research scientists (often PhD students), contextualise aspects of the curriculum and allow pupils to experience for themselves the excitement of discovering something new. By designing projects focused on issues of current concern, such as air pollution or biodiversity loss, pupils will learn first-hand how scientific advances can address real-life challenges and how they and their teachers can personally contribute.

5.22. These practical projects should form part of the standard offer for all students but are currently only available to those who take part in schemes such as the Royal Society’s Partnership Grants programme. The Royal Society recommends that all young people take part in hands-on practical science throughout their school career as a matter of routine.

[43] OECD. https://pisa-framework.oecd.org/science-2025/

6. Technical and Further Education

6.1. The Royal Society believes that all young people should have access to high-quality technical education courses and that these should carry equal esteem as traditional 'academic' pathways. There needs to be a cultural shift in attitudes towards technical education, so that pupils are encouraged to undertake technical qualifications which will prepare them for a rapidly changing workplace. In addition, more needs to be done to fund post-16 provision in colleges to create equity between colleges and schools.

6.2. In the United Kingdom, technical education has long been treated as the poor relation to academic study, often regarded as a less prestigious pathway. This imbalance is evident in funding disparities; for example, in 2016, the UK spent £6,990 per technical education student, significantly below the OECD average of £8,080, and far less than countries such as Germany and the Netherlands, where investment in technical education is considerably higher[44].

6.3. Moreover, the post-16 education system has been criticised for failing to adequately prepare students for technical routes. The 2016 Independent Panel on Technical Education highlighted that many young people were not ready to access technical education at age 16 and recommended the introduction of a flexible transition year tailored to individual needs[45].

6.4. There is still work to do to change public perceptions of technical qualifications and educational choices. Technical and vocational routes should not be seen as an "alternative" pathway through education but be valued in their own right and lead to qualifications that can sow the seeds for successful careers and/or further study.

6.5. The curricula of technical courses need to be co-created with business and industry to ensure that the knowledge and skills young people acquire are directly relevant to the careers they plan to enter. Ensuring that the curriculum is linked to business needs means that young people are given the opportunity to gain the necessary skills to directly enter the workforce while providing local businesses with a highly skilled workforce.

6.6. While T Levels provide valuable technical pathways through education, recent reports from Ofsted[46] and the Edge Foundation[47] on learner experiences of these courses have highlighted the high level of content, the amount of assessment and the limited opportunities for practical, hands-on work. The Royal Society would like to see further reviews of the course content and assessment methods currently used in T Level courses.

---

[44] EPI. https://epi.org.uk/publications-and-research/international-comparison-of-technical-education/

[45] The Independent Panel on Technical Education. https://assets.publishing.service.gov.uk/media/5a8075a7e5274a2e8ab50444/Report_of_the_Independent_Panel_on_Technical_Education.pdf

[46] Ofsted. https://www.gov.uk/government/publications/t-level-thematic-review-final-report/t-level-thematic-review-final-report

[47] Edge Foundation. https://www.edge.co.uk/research/projects/research-reports/what-do-students-really-think-about-t-levels/

6.7. Students taking technical courses are also at risk of experiencing a lack of breadth in their studies by being restricted to one area or field compared to studying a wider range of GCSEs or post-16 choices. This is particularly narrow compared to other countries across Europe, where students on technical courses are also expected to study a wide range of subjects alongside their qualification[48].

6.8. Many teachers and lecturers working in further education receive lower salaries compared to those in schools. In 2021, further education teachers tended to earn 23% less than those in other roles in the education sector[49]. Addressing this disparity could be the first step to achieving a greater sense of parity between technical and academic or general education routes.

6.9. In addition, the provision of professional development across the technical education sector is key to ensuring that courses are being taught by suitably qualified and motivated teachers. A recent review of T Level courses by Ofsted found that teachers do not always have the required level of technical expertise or experience of teaching theoretical content[50].

6.10. Current policy requiring students to resit GCSE Mathematics multiple times in pursuit of a passing grade has a particularly detrimental effect on the further education sector. Making changes to this resit policy, alongside changes to the way mathematics and data education can be taught, would encourage greater attendance and engagement with learning. Offering a more contextual and appropriate version of mathematical education for these students could also benefit progression routes beyond 18.

[48] EDSK. https://www.edsk.org/wp-content/uploads/2024/05/EDSK-Evolution-and-revolution.pdf

[49] NFER. https://www.nfer.ac.uk/media/ms5olfqv/building_a_stronger_fe_college_workforce.pdf

[50] Ofsted. https://www.gov.uk/government/publications/t-level-thematic-review-final-report/t-level-thematic-review-final-report#main-findings

7. Computing education

7.1. Computing education suffers from uneven provision across the country, as well as a lack of expert teachers and barriers for underrepresented groups to choose the subject at GCSE level and beyond. Reform is urgently needed to change computing education, including providing pathways for both specialist computing students, and a more applied route. In addition, changes need to be made to ensure inclusivity and an emphasis on encouraging students from currently underrepresented backgrounds are central to a reformed computing curriculum at GCSE and beyond.

7.2. The Royal Society supports increased participation in computing education for all young people, but we are particularly concerned by the low levels of participation by girls. Young girls' computing identities and capital should be supported over time in the computing classroom through the incorporation of diverse female role models in computing careers in the curriculum. Peer sexism should be challenged to create more inclusive computing cultures. Government and industry-funded interventions must prioritise and evaluate their impact on improving the gender balance of computing.

7.3. The UK's digital skills gap is estimated to cost the economy £63 billion per year, and is expected to widen in the future, resulting in a workforce inadequately equipped to meet the demands of the digital age[51]. In addition to the specific and specialised skills gaps that need addressing, everyone needs to have a basic level of digital literacy in a world where computing and technology is widespread. Currently only 48% of students leave full time education with the digital skills needed and employers cite lack of talent as the biggest constraining factor to their growth[52]. Not enough young people are studying and gaining qualifications in computing subjects to meet the demands for digital skills, and the computing workforce does not yet reflect the UK's diverse society.

7.4. In 2023, only 21% of IT specialists in the UK were women, which not only constrains the workforce but also has wider implications for gender inequality[53]. Women and girls play a critical role in science and technology communities and their participation in computing education should be strengthened to reach gender balance in these fields. It is important to open computing opportunities to girls and students from a broad range of backgrounds to help meet the UK's skills needs, and drive innovation and creativity whilst also enabling all young people to pursue fulfilling and potentially lucrative careers.

7.5. The number of students taking computing courses at secondary level is low, and disproportionately low for females, driving the UK's skills gap. Just over 10% of young people take GCSE Computer Science each year, much lower than for many other major optional subjects, and boys outnumber girls 4 to 1. The number of entries for computing GCSEs declined following the introduction of GCSE Computer Science in 2013 and the termination of GCSE Information and Communication Technology (ICT) in 2019. Overall, there has been a 34% decline in entries across ICT and Computer Science GCSEs since 2015[54].

---

[51] DCMS. https://www.gov.uk/government/publications/uks-digital-strategy/uk-digital-strategy#s3

[52] DCMS. https://www.gov.uk/government/publications/uks-digital-strategy/uk-digital-strategy#s3

[53] BCS. https://www.bcs.org/policy-and-influence/equity-diversity-and-inclusion/bcs -diversity-report-2024-addressing-the-under-representation-of-women-in-technology/

[54] Department for Education. *A level and other 16 to 18 results*. https://explore-education-statistics.service.gov.uk/find-statistics/a-level-and-other-16-to-18-results

7.6. Policymakers and practitioners should consider the different values and attitudes of underrepresented groups or those who are not well engaged with school when planning interventions to broaden participation in computing. Connecting technical curricula to more tangible real-world problems across other interests will engage and broaden students' understanding of computing.

7.7. Consistent, dedicated coverage of computing in all schools, and grade-parity between computer science and other STEM subjects is important to increase the number of students that see computing as a viable option for further study. Computing needs to be taught as a dedicated lesson with sufficient hours timetabled each week alongside coverage of computing in the arts and humanities.

7.8. Teachers should highlight how, in addition to presenting its economic value, pursuing study and training in computing will allow young people to progress into a broad range of careers and contribute to solving global and societal challenges that will benefit humanity.

7.9. In 2013, the national curriculum subject ICT was replaced with computing and enforced from September 2014 for key stages 1- 4. A GCSE in computer science was introduced by exam boards from September 2013, and GCSE ICT ceased to exist from 2019. After the curriculum change, the number of ICT/computing teaching hours taught in state schools dropped by 60% at key stage 4 and 28% at key stage 3 between 2012 and 2020, correlating with the decrease in students choosing computing qualifications[55]

7.10. A survey of students found almost one third (32%) receive two or more hours of computing a week and 17% receive less than one hour per week. The amount of time afforded to computing education is insufficient to teach the subject content in the national curriculum, making it difficult for schools to achieve the aims of the national curriculum, and having reduced teaching hours increases the workload of teachers to cover the curriculum in a short amount of time[56]. Furthermore, despite computing being a mandatory subject in the national curriculum, inconsistencies with its delivery in schools mean some pupils finish formal study of computing at 14[57]. Not only is there a risk that students will be unequipped for GCSE and post-16 qualifications in computing, the status of computer science as a subject may be undermined. The range of qualifications should include pathways suitable for all pupils, with an immediate focus on information technology vocational and technical qualifications at key stage 4.

7.11. Subject content should be developed and accredited to enable more people from a wider variety of backgrounds to become computing teachers, including conversion courses for existing teachers of other subjects, and braided careers for those in industry and academia. Training should focus support in the areas of the UK with high levels of deprivation. Governments and industry need to play an active role in improving CPD for computing teachers and financial support should be made available to schools to release staff and attend professional development opportunities.

---

[55] Kemp, P., Wong, B., Hamer, J., & Copsey-Blake, M. 2024. https://www.kcl.ac.uk/ecs/assets/kcl-scari-computing.pdf

[56] The Royal Society. https://royalsociety.org/-/media/policy/projects/computing-education/computing-education-report.pdf

[57] BCS. https://www.bcs.org/media/2936/scac-ofsted-response-0419.pdf

8. Assessment

8.1. The Royal Society advocates for a comprehensive reform of the assessment system, moving away from the current over-reliance on high-stakes exams which promote memorisation and recall over other skills. Instead, the Society would encourage the Review Group to explore broader and more authentic methods of determining students' capabilities. A new system could integrate a range of assessment methods including teacher assessment, practical work, project-based assessment and/or digital portfolios. These methods should focus on evaluating students' abilities in problem-solving, critical thinking, and the real-world applications of knowledge, particularly in STEM subjects.

8.2. Teachers should have a central role in the assessment process to better capture the ongoing development of student skills, and qualifications should be designed to reflect a broader range of competencies that are essential for success in both higher education and the workplace. Improving the diversity of assessments can free up valuable time in the curriculum, as well as avoiding 'cliff edge' measures for schools. With less focus on end-of-year testing, students and teachers would be able to engage more deeply with the subject matter, exploring a broader range of topics and skills. It would also create space for innovative teaching methods and a richer educational experience that prepares students for real-world challenges.

8.3. Good GCSE qualifications in English and mathematics are typically required for progression to further and higher education courses and for many areas of employment. Although it is right that students leave full-time education with appropriate levels of competence in these areas, more than a third of students do not achieve a standard pass (grade 4) in GCSE Mathematics at the first attempt. Under the condition of funding, introduced in England from 2014, these students must continue to study mathematics during their post-16 education and are required to resit the GCSE examinations until they achieve a grade 4 or above or else study for a Functional Skills qualification in the subject.

8.4. Regrettably, this policy change is not succeeding as the percentage of GCSE resit students attaining a grade 4 or above has decreased since the condition of funding was introduced, with fewer than a quarter achieving this benchmark by age 18. For the many thousands of young people who leave education without a grade 4 in GCSE Mathematics, their future employment and life opportunities are seriously diminished, with negative knock-on impacts on society and the economy. Furthermore, the 80% increase in the numbers of resit students observed since the introduction of the condition of funding has created considerable added strain on the education system, particularly for educational providers and teachers[58].

8.5. Assessment reform should not just take place across the traditional 'academic' qualifications, and any future review must consider the extensive suite of technical and vocational assessment and qualifications available across the secondary and further education sectors. Government and awarding bodies should seek to use imaginative and innovative assessment, making use of education technology, to assess progress in technical and vocational education. There is already precedence for alternative assessment styles within the chartered and professional registration for engineers, for example.

[58] The Royal Society. https://royalsociety.org/news-resources/projects/mathematics-education/gcse-mathematics-resits/

8.6. Reliance on high stakes assessment, currently linked to school performance and accountability, distorts the teaching and learning of science[59]. It has led many schools to start teaching key stage 4 at least a year earlier than intended and resulted in a culture of 'teaching to the test' that focuses prematurely on preparing students for public examinations and reduces the richness of their science education, for instance by narrowing their experience of practical inquiry.

8.7. Any review of the current assessment systems within the UK must look at alternative methods of assessment beyond the traditional high stakes summative exams that the system currently relies on. Discussions across the education sector and beyond have recently explored the possibility of baccalaureate style education, which usually features a range of assessment methods:

- Baccalaureate-style systems allow students to study a wider range of subjects, as well as a wider range of qualifications. Practical learning, project-based learning, Higher Project and Extended Project Qualifications, performance-based assessment, oral assessment and more could be features of a baccalaureate-style education system.

8.8. Extended Project Qualifications (EPQs) and Higher Project Qualifications (HPQs) are alternative methods of assessing a wider range of skills including time management, problem-solving and creativity, while providing beneficial preparation for higher education[60]. While these qualifications may prove a credible complement to the current exam system, it is important to consider the additional funding and resources they require, and to carefully navigate some of the challenges of implementation, including authenticating individuals' work.

8.9. Good evidence exists showing that open-ended practical inquiry activities (those that do not have a preordained outcome, such as original research projects) can provide students with authentic experiences of working scientifically and enhance their self-confidence, learning and motivation[61]. The Science Education Tracker shows that less than 10% of students have the opportunity to engage in project work of this sort. Open-ended practical inquiry activities should become a mainstream component of science education for all students. In the meantime, as much as possible should be done to promote the plethora of effective STEM-enrichment activities that exist, such as the Royal Society's Partnership Grants scheme, and Ofsted inspections should monitor schools' uptake of them and of existing project qualifications.

8.10. A 'stage not age' approach to qualifications where appropriate could help to improve pass rates for certain subjects, including mathematics, act as better benchmarks for young people's competence in core areas, and allow students to focus on their own knowledge, skills and development.

8.11. Particular attention should be given to alternative approaches to assessing hands-on practical learning in science, which is not currently assessed effectively. Consideration should be given to introducing project-based assessments and non-traditional methodologies, including ones using digital technologies, where evidence

[59] Moore, A. M., Fairhurst, P., Bennett, J. M., Harrison, C., Correia, C. F., & Durk, J. 2024. https://www.tandfonline.com/doi/epdf/10.1080/09500693.2023.2253366

[60] Gill, T. 2024. https://www.tandfonline.com/doi/epdf/10.1080/03054985.2024.2325966

[61] The Royal Society. https://royalsociety.org/-/media/policy/projects/science-education-tracker/practical-inquiry-in-science-education-evidence-synthesis.pdf; The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

exists showing these may provide a more valid way to assess students' practical learning and conceptual understanding[62,]

GCSE qualifications

8.12. Summative assessment of the sciences at secondary level needs to be reformed alongside the curriculum so that it provides a more valid and useful measure of individual students' scientific literacy. This may be achieved by ensuring assessment:

- focuses more on conceptual understanding and application of knowledge than on recall of 'factual' knowledge;
- involves a range of methods capable of reliably evaluating candidates' knowledge, understanding and capabilities;
- fairly evaluates and recognises what students know and can do in ways that reward varied types of knowledge and skills.

8.13. Science is an outlier, being the only subject offered at GCSE with multiple routes: Combined Science (aka Double Award Science) includes a blend of biology, chemistry and physics leading to a double GCSE qualification, whereas Triple Science involves studying a wider range of topics across each of these three sciences, potentially leading to single GCSE qualifications in each one (although some students may take a single GCSE in one science or some combination of biology, chemistry and physics GCSEs).

8.14. The commitment to two pathways through science to age 16 has had two major negative consequences. Firstly, it has constrained the breadth of subjects studied by many students, thereby narrowing their education. Secondly, it has led to significant disparities in candidacy.

8.15. Data released by the Department for Education accompanying this Call for Evidence show that of all pupils completing KS4, 65% are entered for Combined Science whereas 25% take Triple Science. Other data suggest that, of these:

- Approximately 80% of students from disadvantaged backgrounds (eligible for free school meals) take Combined Science GCSE compared to 66% of students from non-disadvantaged backgrounds[63].
- By contrast, approximately 15% of students from disadvantaged backgrounds take Triple Science GCSE compared to nearer 30% of students from non-disadvantaged backgrounds[64].
- A student's ethnicity also correlates with their likelihood of studying Combined Science or Triple Science, for instance, Asian students are more likely to study Triple Science than Combined Science[65].

---

62 Erduran, S., Masri, Y. E., Cullinane, A.,, & Ng, Y. P. D. 2020. https://www.pure.ed.ac.uk/ws/portalfiles/portal/300031802/Assessment_of_practical_science_in_high_stakes_examinations_a_qualitative_analysis_of_high_performing_English_speaking_countries.pdf

63 STEM Learning. https://www.stem.org.uk/sites/default/files/pages/downloads/Science%20Education%20in%20England%20Summary.pdf

64 STEM Learning. https://www.stem.org.uk/sites/default/files/pages/downloads/Science%20Education%20in%20England%20Summary.pdf

65 The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

8.16. Students taking Triple Science (ca. 175,000 entries in 2024) are significantly more likely to pursue science post-16 than students who take Combined Science (ca. 927,000)[66]. In fact, work by Cambridge Assessment has shown that of all students taking Combined Science in 2020, just 4%, 2% and 1%, respectively, progressed to take biology, chemistry and physics A levels[67]. By comparison, 25% of Triple Science GCSE biology candidates progress to biology A level, with 23% and 16%, respectively, of GCSE chemistry and GCSE physics candidates progressing to A levels in these subjects[68].

8.17. While Combined Science is universally offered, Triple Science is not available in all schools.[69]Availability is also unevenly spread, with the Sutton Trust reporting that 20% of 'highly able' pupils eligible for free school meals attend schools where Triple Science is not offered, compared to 12% of higher-attaining pupils from more advantaged backgrounds.

8.18. The Science Education Tracker shows that a fifth of students (19%) who would have wanted to take Triple Science were unable to, either because it was not offered at all (3%) or because it was selectively not offered to them (15%)[70]. The ASPIRES 2 report noted that triple science is overwhelmingly seen as the route for those who are 'clever' and 'science-y'[71]. However, while Triple Science includes a wider range of topics, all are studied to the same depth as topics in Combined Science.

8.19. In addition, the Science Education Tracker shows that students who study Triple Science have: more timetabled time for science; more opportunities to engage in hands-on practical science; and are less likely to be asked to watch videos of practicals[72].

8.20. By contrast, the Science Education Tracker also shows that students taking Combined Science are less likely to:

- have strong family science connections ('science capital');
- be engaged with national culture through visiting attractions such as zoos, science museums, theatres and art galleries;
- be interested in studying the sciences (biology, chemistry, physics);
- perceive themselves as being 'good' at the sciences;

---

[66] Ofqual. https://www.gov.uk/government/statistics/provisional-entries-for-gcse-as-and-a-level-summer-2024-exam-series/provisional-entries-for-gcse-as-and-a-level-summer-2024-exam-series; Francis, B., Henderson, M., Godec, S., Watson, E., Archer, L., & Moote, J. 2023. https://doi.org/10.1080/02671522.2023.2283417

[67] Williamson, J., & Vidal Rodeiro, C.L. 2024. https://www.cambridgeassessment.org.uk/Images/707601-progression-from-gcse-to-a-level-2020-2022.pdf

[68] Williamson, J., & Vidal Rodeiro, C.L. 2024. https://www.cambridgeassessment.org.uk/Images/707601-progression-from-gcse-to-a-level-2020-2022.pdf

[69] Teacher Tapp. https://teachertapp.co.uk/articles/triple-science-teaching-arrangements-in-schools/#:~:text=A%20science%20teacher%20got%20in%20touch%20with%20Teacher%20Tapp%20wanting

[70] The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

[71] Archer, L., Moote, J., MacLeod, E., Francis, B., & DeWitt, J. 2020. https://www.sciencecentres.org.uk/documents/493/Aspires_2_Exec_Summary.pdf

[72] The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

- think it is important to do well in science or that science is relevant to real life;
- aspire to progressing to higher education (or to have parents that were university-educated);
- have done work experience in or outside STEM;
- be interested in environmental sustainability.

8.21. The Royal Society therefore recommends the restructuring of the science curriculum to provide universal access to a single, comprehensive science pathway at GCSE. By eliminating the divide between Combined Science and Triple Science, all students—including those from disadvantaged backgrounds—can equally study biology, chemistry, and physics, enhancing their potential to pursue science post-16.

8.22. The changes to exam board specifications introduced in 2018 have had the unforeseen, highly detrimental, consequence of marginalising access to hands-on practical science[73]. Specifically, Ofqual's decision to allow exam boards to specify a minimum number of practical activities that students must complete during GCSE sciences has had the unintended consequence of disincentivising teachers from offering wider practical learning opportunities in science.

8.23. Prescribed practicals are procedural in nature, requiring students to follow a set of steps to achieve a pre-ordained result. These 'cookbooks' are useful for demonstrating certain phenomena and helping develop technical and manipulative skills, but they are treated as 'tick box' exercises and have limited worth, especially as their relevance to 'real life' is often not apparent and because they do not reflect how scientific research is conducted. Ofsted found that in a 'significant minority' of schools, "the focus was on covering content or completing practical activities. In both cases, the curriculum goal, that is what pupils needed to learn and remember, got lost. This led to pupils studying science, often for long periods of time, without developing sufficient substantive and disciplinary knowledge."[74]

[73] The Royal Society. https://royalsociety.org/news-resources/projects/science-education-tracker/

[74] Ofsted. https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2#discussion-of-the-main-findings