Curriculum and Assessment Review – ASE submission for call for evidence

November 2024

10. What aspects of the current (a) curriculum (b) assessment system and (c) qualification pathways are working well to support and recognise educational progress from children and young people?

Science is rightly a core subject alongside English and mathematics, and should remain so, given that science and STEM uniquely support the government's priorities for economic growth and reaching net zero through a diverse green highly skilled workforce and a scientifically literate society.

Although primary science is not given equal status and curriculum time with the other core subjects, and there are curriculum and assessment issues to be addressed at secondary level, as outlined in this response from ASE, there are nevertheless many schools demonstrating excellent leadership and effective classroom teaching and learning through the quality, dedication and creativity of their workforce.

11. What aspects of the current a) curriculum, b) assessment system and c) qualification pathways should be targeted for improvements to better support and recognise educational progress for children and young people?

Overview: The curriculum is content heavy, outdated in places, prioritises rote memorisation over critical thinking, problem solving and practical skills and discourages cross-disciplinary exploration. This is compounded by an overreliance on testing for external accountability at key stage 4 (GCSE level) and post 16 (A levels and equivalents), which fosters a culture of "teach to the test" where educators prioritise exam technique over deep understanding and application of knowledge. This approach can exacerbate inequities in educational outcomes and stifle creativity and innovation. On equity and inclusion, there are often disparities in science education and attainment among different schools and communities. Evidence shows a correlation between socio-economic disadvantage and less engagement and attainment in STEM subjects. Low socio-economic status is also associated with less well-equipped laboratories and digital resources, and lower availability of well qualified science teachers. This can result in certain groups of students being left behind in, leading to social and economic disparities in STEM fields.

There is evidence that school science is not fully engaging all students:

- E.g. "Make it more relevant and practical": Young People's Vision for School Science in England A survey of c.7,000 young people at age 21-22 found that "only around two fifths (39%) of young people said that they had enjoyed school science, and 20% felt that school had put them off science. Example quotes from survey responses: "I feel like if the

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teacher's unenthusiastic then you're not interested and then you just hate science, which is kind of what happened with me… I think if I'd had a really enthusiastic teacher, I would've been much more likely to have done it further." White, working-class woman, non-STEM student)

- In response to the question, "How could your experience of school science have been improved?", the vast majority of young people identified areas for change – only 5% felt that no improvements were needed.

See also DeWitt, J., Osborne, J., Archer, L., Dillon, J., Willis, B., & Wong, B. (2011). Young Children's Aspirations in Science: The unequivocal, the uncertain and the unthinkable. International Journal of Science Education, 35(6), 1037-1063. https://doi.org/10.1080/09500693.2011.608197; and Osborne, J. F., Simon, S., & Collins, S. (2003). Attitudes towards Science: A Review of the Literature and its Implications. International Journal of Science Education, 25(9), 1049–1079.

The curriculum is not developed from the science principles underpinning the science education of all young people, through the big ideas of and about science, to enable them to understand the scientific aspects of the world around them and make informed decisions about the applications of science. In response to concerns that many students did not find their science education interesting or see it as relevant to their lives, 'Working with the Big Ideas of Science Education' sets out the rationale for working towards big ideas and the implications of this for curriculum content, pedagogy, student assessment and teacher education. Principles and Big Ideas of Science Education | www.ase.org.uk.

The substantive content heavy curriculum, particularly from KS4, with little opportunity to develop the practices and ways of thinking about science, and the sciences, is designed principally to prepare students for further study in science, and so does not meet the needs of the majority of young people as critical consumers of scientific information and its applications.

See Millar, R., & Osborne, J. F. (Eds.). (1998). Beyond 2000: Science Education for the Future. King's College London. https://www.nuffieldfoundation.org/wp-content/uploads/2015/11/Beyond-2000.pdf; National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. N. A. Press; and Osborne, J. F., & Pimentel, D. (2022). Science, misinformation, and the role of education. Science, 378(6617), 246-248. https://doi.org/10.1126/science.abq8093

The curriculum does not provide sufficient opportunities for young people to develop their competencies of knowledge, attitudes, skills and values in relation to the environment, climate education and sustainability. The Science Education Tracker 2023 | Royal Society noted that 42% of young people are interested in learning about the climate. However, teaching and learning

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about climate change is currently ad hoc, piecemeal across several subjects, repetitive and focuses on the causes and problems rather than on the solutions – contributing to 'climate anxiety'. ASE recommends that there should be greater coherence and consistency about the teaching of climate change (plus the environment and sustainability); and that consideration should be given to specifying content relating to climate change (plus the environment and sustainability) and how to work towards addressing these global challenges in a coordinated, interdisciplinary way across biology, chemistry and physics, as well as geography and citizenship education.

Practical work in school science is essential for the development of subject-specific skills and understanding, for the development of transferable skills and competences that are valuable in further study and a wide range of careers, and because it increases student engagement and motivation. It must therefore be protected and promoted in the science curriculum. However, some students have an impoverished experience of practical work, in part due to the substantive content heavy curriculum, its assessment at GCSE, increased use of digital support for practical work, which accelerated during, and potentially beyond, the covid period, alongside a decline in opportunities for student teachers and early career teachers to develop their pedagogies and practice for purposeful and effective practical work.

The 'PASS' project was a 3.5-year empirical research study on the assessment of disciplinary knowledge and practical skills in secondary school science and the associated pedagogy. It provides empirical evidence that some increasingly common instructional methods (such as video demonstrations of practical work) are not as effective as others (such as hands-on practical work and teacher-led demonstrations) in developing disciplinary knowledge and practical skills. The findings suggested that the characteristics of teacher and student behaviour that were associated with better learning were most prominently observed in practical work that was 'guided, active and purposeful' (GAP). Furthermore, the 'PASS' project provides empirical evidence that national, high-stakes assessments in England are not incentivising hands-on practical work and high-quality teacher demonstrations as effectively as they could be, and identifies ways in which the assessments could be optimised.

Moore, A. M., Fairhurst, P., Bennett, J. M., Harrison, C., Correia, C. F., & Durk, J. (2024). Assessment and practical science: identifying generalizable characteristics of written assessments that reward and incentivise effective practices in practical science lessons. *International Journal of Science Education,* 46(7), 643-669. https://doi.org/10.1080/09500693.2023.2253366

Moore, A. M., Fairhurst, P., Correia, C.F., Harrison, C. and Bennett, J.M. (2020). Science practical work in a COVID-19 world: are teacher demonstrations, videos and textbooks effective replacements for hands-on practical activities? *School Science Review*, 102(378), 7-12. https://www.ase.org.uk/system/files/SSR_September_2020_007-012_Moore.pdf

The unsatisfactory experience of practical work impacts students' engagement and attitudes to practical work, and science more broadly. The Science Education Tracker 2023 | Royal Society noted the following: Among all students in years 7–11, the most common form of exposure to practical science was via video: 49% reported watching a video of a practical at least once a fortnight, compared with 44% watching a teacher demonstration, and 38% doing hands–on practical work. Seven in ten students in years 7–11 wanted to do more practical work, with rising levels of demand among those who do this least frequently: 61% who did hands–on practical work at least fortnightly wanted to do more compared with 79% who do practicals less often. The appetite for more practical work was higher among groups with lower levels of engagement in science. Students who were not interested in science or who do not see science as 'for me' were associated with higher levels of feeling that they wanted to do more.

As noted by ASE's The Language of Mathematics in Science project https://www.ase.org.uk/mathsinscience, concerns have often been raised by teachers of GCSE sciences about the level of understanding of the mathematical aspects of science amongst students. Confusion may be caused, for instance, when mathematics and science teachers use different terminology or approaches when explaining ideas. Greater clarity and coherence are needed when working with mathematical ideas, language and procedures in science and mathematics lessons, to help children transfer their mathematical skills and understanding effectively to their science learning. ASE, in partnership with MEI as part of the Advanced Maths Support Programme (AMSP), notes teachers' feedback that some of their students are not secure in their understanding and application of GCSE maths and need support in developing their understanding of ideas in maths such as size and number, ratio and proportion, before being able to access further ideas such as statistics in A level Biology.

Responding to the proliferation of data and misinformation, students experience of mathematics in science (and other subjects) from KS4 needs to broaden their digital and statistical literacy. The existing post-16 Core Maths qualifications support the development of general quantitative literacy and are well received by students, but the proportion of centres offering these qualifications remains low. There is potential to further develop and extend Core Maths qualifications, to include, for instance, calculus to support those students taking A level Physics but not A level Mathematics. In line with the recommendations of the Mathematical Futures programme | Royal Society, there is a need for a curriculum that strengthens spatial reasoning in primary education and, in later phases, integrates appropriate data, statistics, and computational tools coherently with mathematics.

The dual science route at GCSE (Double / Triple science) hinders progression and exacerbates/ sustains social inequalities, with research suggesting that those who take Triple science are more likely to pursue the study of science post-16, whilst for those taking Double science the likelihood of future participation in science is significantly diminished.

- Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England. *Research Papers in Education*. Published online 29 August 2016, DOI 0.1080/02671522.2016.1219382
- Francis, B. et al. (2023) An exploration of the impact of science stratification in the English school curriculum: the relationship between 'Double' and 'Triple' Science pathways and pupils' further study of science. *Research Papers in Education*.
- ASPIRES 2 Triple science project spotlight. (2018). London: UCL Institute of Education.

See also ASE's response to the House of Lords inquiry on 11-16 education in England https://www.ase.org.uk/news/launch-of-lords-report-11-16-education and ASE's election pledges (April 2024) https://www.ase.org.uk/news/four-election-pledges-help-transform-science-education-brighter-future.

12. In the current curriculum, assessment system and qualification pathways, are there any barriers to improving attainment, progress, access or participation (class ceilings) for learners experiencing socioeconomic disadvantage?

Differential classed access to key forms of cultural capital create inequalities in progression. E.g.

- Archer, L., Francis, B., Henderson, M., Holmegaard, H., Macleod, E., Moote, J. & Watson, E. (2023) Get Lucky? Luck and Educational Mobility in Working-Class Young People's Lives from age 10-21. *British Journal of Sociology of Education.* *Get lucky? Luck and educational mobility in working-class young people's lives from age 10–21 (tandfonline.com)*

Setting disproportionately negatively impacts working-class learners (who receive an impoverished curriculum, unequal allocation of teachers, etc)

- Archer, L., Francis, B., Miller, S., Taylor, B., Tereschenko, A., Mazenod, A., Pepper, D., and Travers, M-C. (2018) The symbolic violence of setting: A Bourdieusian analysis of mixed methods data on secondary students' views about setting *British Educational Research Journal, 44(1): 119-140* https://doi.org/10.1002/berj.3321
- Francis, B., Craig, N., Hodgen, J., Taylor, B., Tereschenko, A., Connolly, P. & Archer, L. (2020) The impact of tracking by attainment on pupil self-confidence over time: an accumulative self-fulfilling prophecy. *British Journal of Sociology of Education.* https://doi.org/10.1080/01425692.2020.1763162
- Francis, B., Archer, L., Mazenod, A., Craig, N., Taylor, B., Tereschenko, A., Hodgen, J. & Connolly, P. (2019) Teacher 'quality' and attainment grouping: the role of within-school teacher deployment in social and educational inequality. Teaching and Teacher Education, DOI:
10.1016/j.tate.2018.10.001
- Tereshchenko, A., Francis, B., Archer, L., Hodgen, J., Mazenod, A., Taylor, B., Pepper, D., Travers, M-C. (2019) Learners' attitudes to mixed-attainment grouping: Examining the views of students of high, middle and low attainment. *Research Papers in Education* 34:4, 425-444, DOI: 10.1080/02671522.2018.1452962
- Connolly, P., Taylor, B., Francis, B., Archer, L., Hodgen, J., Mazenod, A. & Tereshchenko, A. (2019) *The misallocation of students to academic sets in maths: A study of secondary schools in England.* British Educational Research Journal. https://doi.org/10.1002/berj.3530

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- Taylor, B., Francis, B., Craig, N., Archer, L., Hodgen, J., Mazenod, A., Tereshchenko, A., Pepper, D. (in press) Why is it difficult for schools to establish equitable practices in allocating students to attainment 'sets'? *British Journal of Educational Studies*.
- Mazenod, A., Francis, B., Archer, L., Hodgen, J., Taylor, B., Tereshchenko, A., Pepper, D. (2018). Nurturing learning or encouraging dependency? Teacher constructions of students in lower attainment groups in English secondary schools. *Cambridge Journal of Education*.

There is unequal allocation of students to double/ triple – low SES learners are less likely to access the higher status triple science route. E.g.

- Education Datalab found that schools with higher attainment pupil intakes had more physics specialist teachers and better entry rates to GCSE physics: Education Datalab (2016). Teachers with a physics degree may improve entry rates to GCSE Physics, but don't appear to affect attainment. Retrieved December 22, 2016, from http://educationdatalab.org.uk/2015/03/teachers-with-a-physics-degree-may improve-entry-rates-to-gcse-physics-but-dont-appear-to-affect-attainment/
- It has been argued that incentives to address science teaching shortages should be targeted at schools in less advantaged areas.: Science-shortfall_FINAL.pdf
- Research conducted by the Sutton Trust has shown that only 13% of Pupil Premium students were taking triple science in 2013, compared to 30% of non-Pupil Premium students.27 While much of this difference can be attributed to prior attainment, a gap nonetheless remains: Allen, R. (2016). Changing the Subject. London: Sutton Trust.
- Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England. *Research Papers in Education*. Published online 29 August 2016, DOI 0.1080/02671522.2016.1219382
- Francis, B. et al. (2023) An exploration of the impact of science stratification in the English school curriculum: the relationship between 'Double' and 'Triple' Science pathways and pupils' further study of science. *Research Papers in Education*.
- ASPIRES 2 Triple science project spotlight. (2018). London: UCL Institute of Education.

There is evidence of differential impact of unequal resourcing and teacher shortages in schools serving socioeconomically disadvantaged populations:

- e.g. Doherty (2020) A systematic review of literature on teacher attrition and school-related factors that affect it | Teacher Education Advancement Network Journal
- Simon and Johnson (2015) Teacher Turnover in High-Poverty Schools: What We Know and Can Do - Nicole Simon, Susan Moore Johnson, 2015

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13. In the current curriculum, assessment system and qualification pathways are there any barriers to improving attainment, progress, access or participation which may disproportionately impact pupils based on other characteristics (e.g. disability, sexual orientation, gender, race, religion or belief etc.)

Setting disproportionately disadvantages Black boys and Black students – who are disproportionately likely to be in lower sets with less access to high quality teachers, full curriculum and restricted opportunities for progression

- See same references on setting as for Q12
- See also ASPIRES3 "Make it more relevant and practical": Young People's Vision for School Science in England) Headline Improvement #3: Reduce exam pressure and broaden forms of assessment · Over half of the young people (52%) called for less exam pressure. Trends: Young people who wanted less exam pressure were more likely to: · be women and non-binary people · have taken A Level science

Value of social justice-orientated approaches e.g. decolonising the curriculum

- Archer, L., King, H., Godec, S. and Chowdhuri, M.N. (2024) 'Applying the principles of culturally sustaining pedagogy to a model for justice-oriented school science pedagogy in England: the science capital teaching approach'. *London Review of Education*, 22 (1), 7. DOI: https://doi.org/10.14324/LRE.22.1.07.
- Jo Boaler social justice approach to teaching maths - Reclaiming School Mathematics: The girls fight back: Gender and Education: Vol 9, No 3
- Experiencing School Mathematics | Traditional and Reform Approaches To
- The Elephant in the Classroom: Helping Children Learn and Love Maths - Jo Boaler - Google Books

There is a need to address gendered etc. representations and framing in the science and maths curriculum which is still giving the message that subjects like maths and physics are 'for boys'. E.g.

1. Boaler: Reclaiming School Mathematics: The girls fight back: Gender and Education: Vol 9, No 3
2. Archer, L., Moote, J. and MacLeod, E. (2020) Learning that physics is "not for me": pedagogic work and the cultivation of habitus among Advanced Level physics students. *Journal of the Learning Sciences.* https://doi.org/10.1080/10508406.2019.1707679
3. Archer, L., Nomikou, E., Mau, A., King, H., Godec, S., DeWitt, J. & Dawson, E. (2018) Can the subaltern 'speak' science? An intersectional analysis of performances of 'talking science through muscular intellect' by 'subaltern' students in UK urban secondary science classrooms, *Cultural Studies in Science Education* https://doi.org/10.1007/s11422-018-9870-4

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3. Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2017). The 'exceptional' physics/ engineering girl: a sociological analysis of longitudinal data from girls aged 10-16 to explore gendered patterns of post-16 participation. *American Educational Research Journal* 54(1)pp: 88-126.
4. Francis, B., Archer, L., Moote, J., DeWitt, J. (2017) The construction of Physics as a quintessentially masculine subject: Young people's perceptions of gender issues in access to Physics: *Sex Roles, 76, 156-174.*

A narrow and overloaded curriculum restricts opportunities to develop personal connection with content – whereas the latter has been found to be associated with progression in chemistry:

1. Archer, L., Francis, B., Moote, J., Watson, E., Henderson, M., Holmegaard, H. and MacLeod, E (2022) Reasons for Not/Choosing Chemistry: Why Advanced Level Chemistry Students in England Do/ Not Pursue Chemistry Undergraduate Degrees. *Journal of Research in Science Teaching* **https://doi.org/10.1002/tea.21822**.

15. In the current curriculum, assessment system and qualification pathways, are there any enablers that support attainment, progress, access or participation for the groups listed above

Through our experience in developing and delivering ASE's Inclusion in Schools programme https://www.ase.org.uk/inclusion-in-schools-programme , ASE recommends that all schools should develop and implement a whole school equity plan with explicit recommendations that teachers challenge stereotypical views about subjects and who can study them and ensure that all students feel that they can take part in all subjects. To encourage schools to develop and implement a whole school equity plan, the IOP initiated the Gender Action project which provides a quality marque to schools that take action on actively challenging all gender stereotyping and expectations.

17. To what extent do the English and maths primary assessments to support pupils to gain an excellent foundation in these key subjects? Are there any changes you would suggest that would support this aim?

In primary science, 'bought in' curricula that are not adapted to the children and their own context, run the risk of turning children off science. If they do not see that science is 'for them', then they are less likely to be interested in and pursue science in later years (see the work of Louise Archer and colleagues).
If primary science lessons become practice for other subjects like English and mathematics, due to accountability pressures, then they are no longer focused on science. Primary science lessons that require a lot of writing, to provide evidence for the application of English writing skills, may not be accessible to those with literacy difficulties. Science can provide a fabulous context for the application of writing, but if science lessons are only about this, then some children may be unable to demonstrate their learning in science.

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In line with the recommendations of the Mathematical Futures programme | Royal Society, ASE recommends a curriculum that strengthens spatial reasoning in primary education.

18. To what extent does the content of the a) English and b) maths national curriculum at secondary level (key stages 3 and 4) equip pupils with the knowledge and skills they need for life and further study? Are there ways in which the content could change to better support this aim?

As noted by ASE's The Language of Mathematics in Science project https://www.ase.org.uk/mathsinscience, concerns have often been raised by teachers of GCSE sciences about the level of understanding of the mathematical aspects of science amongst students. Confusion may be caused, for instance, when mathematics and science teachers use different terminology or approaches when explaining ideas. Greater clarity and coherence are needed when working with mathematical ideas, language and procedures in science and mathematics lessons, to help children transfer their mathematical skills and understanding effectively to their science learning. Responding to the proliferation of data and misinformation, students experience of mathematics in science (and other subjects) from KS4 needs to broaden their digital and statistical literacy.

19. To what extent do the current maths and English qualifications at a) pre-16 and b) 16-19 support pupils and learners to gain, and adequately demonstrate that they have achieved, the skills and knowledge they need? Are there any changes you would suggest that would support these outcomes?

The existing post-16 Core Maths qualifications support the development of general quantitative literacy and are well received by students who are not taking A level Mathematics along their science A level(s), but the proportion of centres offering these qualifications remains low. There is potential to further develop and extend Core Maths qualifications, to include, for instance, calculus to support those students taking A level Physics but not A level Mathematics. In line with the recommendations of the Mathematical Futures programme | Royal Society, ASE recommends a curriculum that strengthens and integrates appropriate data, statistics, and computational tools coherently with mathematics.

22. Are there particular curriculum or qualifications subjects* where: a) there is too much content; not enough content; or content is missing; b) the content is out-of-date; c) the content is unhelpfully sequenced (for example to support good curriculum design or pedagogy); d) there is a need for greater flexibility (for example to provide the space for teachers to develop and adapt content)? Please provide detail on specific key stages where appropriate. *This includes both qualifications where the government sets content nationally, and anywhere the content is currently set by awarding organisations.

Students and teacher views suggest that most feel there is too much content for science – which in a high-stakes, pressured system encourages teaching to the test, which has a negative impact on teachers and students, restricting the space to help develop understanding and interest/passion. Additionally, there is evidence that science (secondary) students complain

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about out-of-date content, with student calls for more relevance plus more (good quality) practical work in science. E.g.

- "Make it more relevant and practical": Young People's Vision for School Science in England
- More relevance and scope to enable students to make personal connections with the subject and find meaning: Reasons for not/choosing chemistry: Why advanced level chemistry students in England do/not pursue chemistry undergraduate degrees - Archer - 2023 - Journal of Research in Science Teaching - Wiley Online Library
- Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E & Seakins, A. (2017). Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London Secondary Science Classrooms. *Science Education 101:741–764. https://doi.org/10.1002/sce.21291*

23. Are there particular changes that could be made to ensure the curriculum (including qualification content) is more diverse and representative of society?

ASE recommends adopting a social justice lens to curriculum (culturally responsive/sustaining pedagogy). E.g.

1. Archer, L., King, H., Godec, S. and Chowdhuri, M.N. (2024) 'Applying the principles of culturally sustaining pedagogy to a model for justice-oriented school science pedagogy in England: the science capital teaching approach'. *London Review of Education*, 22 (1), 7. DOI: https://doi.org/10.14324/LRE.22.1.07.
2. Culturally sustaining pedagogies (Paris, 2012), responsive and/or relevant pedagogies (Ladson-Billings, 1995, 2014) (Paris and Alim, 2014)

Curriculum content, examples and perspectives in science and the sciences should recognise that the development of the disciplines relied on ideas and thinking from many people and varied groups globally. Children should be given the opportunity to learn about historic contributions to the sciences from around the world, as well as the cutting-edge contemporary research produced by diverse teams of scientists.
Ideas should be framed in the context of the times in which discoveries were made and accredited within western science. They can explain how many of those discoveries drew on earlier work in other parts of the world and how, during the period of growth of western science, different groups, cultures and nations were more or less able to participate in research, resource scientific activity, or claim credit and ownership for ideas. This can be achieved by teachers building on their understanding of students' interests, aspirations, local communities and past experiences and using examples and settings that are familiar and local to students as 'hooks' into the science content.
For the purposes of curriculum design, this means providing some example contexts and keeping space in the curriculum for teachers to provide their own contexts.

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See also Top Tips for Inclusive Science Teaching as part of IOP's Limit Less campaign. Some of these apply to curriculum design:

- Look for, examine and challenge stereotypes, biases and assumptions within any science or physics curriculum
- Model inclusive language in curriculum documents
- Build scientific vocabulary
- Provide space to:
    - Teach about a range of jobs and careers that use science and science skills
    - Encourage student discussions
    - Give students opportunities to make links between their learning and their lives, interests and local area
    - Think about and get to grips with the maths.

25. In which ways does the current primary curriculum support pupils to have the skills and knowledge they need for life and further study and what could we change to better support this?

The Primary Science Capital Approach https://www.ase.org.uk/resources/journal-of-emergent-science/issue-23/research-review-primary-science-capital-teaching and https://www.ucl.ac.uk/ioe/departments-and-centres/departments/education-practice-and-society/research/stem-participation-social-justice-research/primary-science-capital-project notes the importance of supporting children to relate to the science they are studying. Linking science to their own real-world contexts can support children to both see that science is 'for them' and build richer conceptual schema. Providing a range of ways to access and record primary science provide a more inclusive experience for children. Examples of different ways to report scientific findings could be included in non-statutory guidance sections, to support teachers.

In primary science, the Working scientifically strand could be expressed more clearly to support practitioners. At the moment, this strand includes learning about science as a discipline, as well as science methods and practices. Key ideas about relating science to real life is often 'hidden' in introductory text, rather than the bullet point lists of content that teachers use, so is too easy to miss. The role and use of practical work is also not clearly expressed; purposeful use needs to be more explicit. Such updates could draw on the work of the TAPS/Focus4TAPS projects https://pstt.org.uk/unique-resources/taps/ and https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/focus4taps, the Nuffield practical work project https://www.nuffieldfoundation.org/project/effective-practical-work-primary-school-science (due to report in March 2025) and the Primary Science

Capital project https://www.ucl.ac.uk/ioe/departments-and-centres/education-practice-and-society/research/stem-participation-social-justice-research/primary-science-capital-project , for example.
In primary science, explicit mention of Biology, Chemistry and Physics in topic titles would support understanding and consistency across phases. Balancing content of all three across KS1 and KS2 would support progression, for example, ensuring age-appropriate representation of Physics at KS1. Such updates should draw on the work of the Primary Curriculum Advisory Group with ASE, IOP, RSB and RSC
https://www.rsb.org.uk/images/edpol/Primary_Curriculum_Advisory_Group_report.pdf and https://www.rsc.org/globalassets/07-news-events/rsc-news/news-articles/2024/08-august/stem-primary-curriculum-recommendations.pdf .

26. In which ways do the current secondary curriculum and qualification pathways support pupils to have the skills and knowledge they need for future study, life and work, and what could we change to better support this?

- The ASPIRES3 survey of over 7,000 21-22 year olds ("Make it more relevant and practical": Young People's Vision for School Science in England) found that a third said that school science had not provided them with any useful knowledge and skills for the workplace at all. As one interviewee explained: "A lot of what I learn scientifically at school is fascinating, but for me, I can't see a use. Maybe I'm just blind; maybe I am using all these things, but apart from knowing in a quiz that table salt is sodium chloride, I don't see many other practical uses." White, middle-class man, non-STEM graduate
- 72% of young people said that they would have liked their school science curriculum to have been more relevant – that is, less abstract and more grounded in contemporary life and societal issues. Trends: Young people who wanted a more relevant science curriculum were more likely to: · be women · be from more socioeconomically privileged areas · have taken A Level science · not be studying or working in STEM field
- By relevance they meant a curriculum more related to my everyday life with more links to personal health and wellbeing, more on climate change and how to protect the environment; less abstract concepts and examples; a more contemporary and inclusive curriculum. A curriculum that is relevant to jobs in, and beyond, science
- 59% wanted more practicals and experiments and More problem-based learning
- Headline: Almost 60% of young people of young people indicated that they would have liked a greater focus on practical and experimental science at school. Trends: Young people who wanted more practical and problem-based science learning were more likely to: · have attended comprehensive schools · have taken A Level science · be studying or working in STEM fields There were no gender, ethnic and socioeconomic background trends, suggesting a broad base of support for more practical science

On a practical level, ASE recommends that the curriculum is developed from the science principles underpinning the science education of all young people, through the big ideas of and about science, to enable them to understand the scientific aspects of the world around them and

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make informed decisions about the applications of science. In response to concerns that many students did not find their science education interesting or see it as relevant to their lives, 'Working with the Big Ideas of Science Education' sets out the rationale for working towards big ideas and the implications of this for curriculum content, pedagogy, student assessment and teacher education. Principles and Big Ideas of Science Education | www.ase.org.uk.

ASE recommends the following initiatives to underpin the structure of the science curriculum framework, which is modern, forward facing and develops students' agency as informed, active citizens and competent contributors to STEM economy.

- The OECD Learning Compass 2030 is an evolving learning framework that sets out an aspirational vision for the future of education, articulating these competencies. Within and across subjects, student agency and co-agency, well-being, and transformative competencies of taking responsibility, reconciling tensions and dilemmas, and creating new value feature prominently. https://www.oecd.org/en/data/tools/oecd-learning-compass-2030.html.
- The OECD's Programme for International Student Assessment (PISA) of 15-year-olds will focus on science in 2025. Through articulating a vision for what young people should know about science and be able to do with science in the future, the draft analytical framework proposes three new knowledge areas of socio-environmental systems and sustainability; development of scientific knowledge and its misuse; and informatics. The framework also adds in two new competencies of using scientific knowledge for decision-making and action; and using probabilistic thinking as well as expanding existing competences to include the ability to research information and design enquiry within complex systems; and to interrogate large data sets as well as use scientific judgements for decision-making. Additionally, the framework includes a new dimension of science identity encompassing science capital, critical science agency, inclusive science experiences and practices, ethics and values. Finally, the framework articulates new competencies for 15-year-olds in Anthropocene Agency. The framework will be informative in shaping potential curriculum reform, and associated assessment, to more effectively meet the needs of all young people to better equip them for the world they will live in. https://pisa-framework.oecd.org/science-2025/ and https://www.oecd.org/en/publications/agency-in-the-anthropocene_8d3b6cfa-en.html.

Consideration should also be given to curriculum frameworks developed for primary science, biology, chemistry and physics: https://www.rsb.org.uk/images/edpol/Primary_Curriculum_Advisory_Group_report.pdf, The fundamentals of 11 to 19 physics | Institute of Physics, https://www.rsb.org.uk/policy/education-policy/curriculum and https://www.rsc.org/policy-evidence-campaigns/chemistry-education/education-reports-surveys-campaigns/chemistry-curriculum-framework/.

Teachers' beliefs influence their practice, yet they rarely have the opportunity in ITE or CPD to start with unpacking teachers' beliefs about the purpose of science education; what teachers believe about how learners of different ages learn best. This means that teachers struggle to understand curriculum statements and this leads to them to implement policy directives and education reform differently, and at times ineffectively. See Biesta, Priestly and Robinson (2015) The Role of Beliefs in Teacher Agency. https://www.tandfonline.com/doi/full/10.1080/13540602.2015.1044325 (Page 64)

Teachers need a curriculum policy that guides, supports and directs their planning for science learning. They need agency too. They need to be able to make professional decisions about the most appropriate way to guide or scaffold learners' experiences in order to develop their process skills alongside their conceptual knowledge. A curriculum needs to be written using words that reinforce the opportunities for teachers' agency. See Manyukina (2024) https://www.tandfonline.com/doi/full/10.1080/03004279.2022.2052232

Curriculum guidance is needed to explicitly link pupils' agentive opportunities with teachers' use of dialogic strategies. Dialogic teaching approaches are argued to improve children's science understanding. See Tao and Chenn (2024) https://www.sciencedirect.com/science/article/abs/pii/S1747938X24000472?via%3Dihub and the Ideas, Evidence and Argument in Science (IDEAS) Project

https://www.stem.org.uk/physical-library/resource/201149/ideas-evidence-and-argument-in-science-ideas-project

In developing the curriculum, ASE recommends an exploration of the following:

- Develop a (short) statement of purpose and rationale for each key stage, and how it supports the learner to progress in substantive and disciplinary knowledge from the previous key stage to the next – before developing the detail within
- Clarify the terminology used so it is explicit and consistent in presentation across the key stages, and with the terminology used in successful curricula elsewhere
- Reduce amount of content (determined by principles and big ideas of science and about science, and the agency needs of today's young people) and prescription so there are fewer more explicit statements outlining what students will know and understand, not what they will deliver, with approximately the same number for each topic/theme – to better guide, support and direct teachers' planning so that teachers can make professional decisions to plan teaching more effectively for their students' learning, using dialogic teaching strategies with assessment for learning in every lesson
- Articulate the common misconceptions of substantive knowledge for each key stage and provide guidance in effectively addressing these misconception, as illustrated by Best Evidence Science Teaching | STEM
- Remove the yearly structure and replace with a whole key stage structure and a progression map of key substantive and disciplinary knowledge, including for practical work, to give schools more flexibility and guidance in delivery
- Include conceptual boundaries, and essential experiences, for each key stage to ensure the learning experience is age and stage appropriate, as illustrated by the Framework for

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a Future Primary Science curriculum https://www.ase.org.uk/news/pcag-publish-report-future-primary-science-curriculum

- Disentangle disciplinary and substantive knowledge because it is currently unclear what the focus is, complicates assessment, and implies a specific classroom activity needed e.g.

Current NC statements	Disentangled version (illustrative only – statements to be developed, refined)
find patterns in the way that the size of shadows change	• (learn how to) find patterns in data and observations • (learn about) the reasons shadows can change size
give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic	• (learn how to) collect evidence from comparative and fair tests • (learn about) everyday materials, including metals, wood and plastic having particular uses
notice that some forces need contact between two objects, but magnetic forces can act at a distance	• (learn how to) observe the way objects behave • (learn about) some forces needing contact between two objects, but magnetic forces can act at a distance
explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment	• (learn how to) use and construct keys for identification • (learn about) the groups and names of a variety of living things in their local and wider environment

- **Cultivate student agency**, with an expectation that students should be given more opportunities to explore own interests in science / students using sciences and working scientifically skills to solve open problems and investigate practically, and to increase their understanding of the wide range of STEM related careers, working with the Gatsby Good Career Guidance: The Next 10 Years and

- **Develop opportunities for interdisciplinary learning across the sciences, and beyond,** alongside understanding of explicit identification with the substantive knowledge, practices and ways of thinking of biology, chemistry and physics – to broaden students' understanding and agency, particularly around addressing environmental, climate and sustainability issues.

For practical work specifically, ASE recommends that:

The curriculum must change to allow more time for practical work. Change is needed in the curriculum to enable more teaching time to be devoted to practical experiences and the development of practical skills including technical and manipulative skills, and transferable creative skills, so students are informed about where their capabilities lie and the preferred post-16 route.

Practical work should include opportunities for students to carry out extended investigations or practical inquiries. Practical science investigations can be divided into two broad groups - experiments and teacher demonstrations, and practical inquires. Experiments and teacher demonstrations are tightly controlled by the teacher. Their strength is to allow pupils to see for themselves known phenomena or illustrate a scientific concept. The degree of cognitive challenge for the learner is varied. These practical science experiences have a place but should not be a dominant form of practical science. Practical inquiries can be classified from level 1 to level 4 by the level of teacher control versus pupils' agency to think and grapple with making sense of data, reflections and critiquing of the process. See for example, a simple description of the levels, Tafoya et al. 19890 https://www.semanticscholar.org/paper/Assessing-Inquiry-Potential%3A-A-Tool-For-Curriculum-Tafoya-Sunal/065b3bc5caa7e09a198e1fb8c00733f15c0100b1 At L4 the teacher's role is one of 'partner', 'mentor', 'guide' 'challenger' and 'information provider' (giving timely intervention, which might be to challenge thinking or actions, or give additional information, etc.). This level, according to the US next Generation Science Standards (2013) and National Research Council (2000) https://www.scirp.org/reference/referencespapers?referenceid=927546 needs to span over more than one single stand-alone science lesson, as time is needed for the pupils to think out loud and consider and challenge ideas and what they observe.

The need for coherent progression pathways for skills development. The curriculum must make clear how practical activities are situated within clearly-mapped and coherent progression pathways for skills development and learning through the 5 years of the secondary school science curriculum. The mapping of these 'big picture' pathways for the development of practical skills/disciplinary knowledge and substantive knowledge will support decision-making as to what should be included - and what could be excluded to reduce teaching and learning load - at each stage of the curriculum.

Summative assessment arrangements must change to better incentivise effective practical work. Change is needed in the summative assessment arrangements in compulsory science education, especially at GCSE level, to ensure they better reward and incentivise high-quality practical experiences such as hands-on practical work that is teacher-guided, purposeful and that actively develops a broad range of skills and understanding.

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27. In which ways do the current qualification pathways and content at 16-19 support pupils to have the skills and knowledge they need for future study, life and work, and what could we change to better support this?

- The ASPIRES 3 survey of over 7,000 21-22 year olds, shows evidence that many students are not feeling prepared for degree by A levels within STEM subjects with differences by subjects and by demographics: [University students' views on A levels UCL ASPIRES research: project blog]
- This analysis looked at whether there were any differences in how well students felt they had been prepared by A levels between students who were taking different subjects at undergraduate level. At opposite ends of the scale, we can see that 61% of Maths degree students agreed that they had been well prepared by their A-Levels, whilst only 37% of Biology students felt the same and 43% computing students and 44% physics (below non-STEM average) 53% engineering, 59% chemistry. Combining across subject areas, **roughly half of all students agreed that their A-Levels had prepared them well for degree study**. However, when we delved deeper into the data some potentially interesting patterns emerged. the percentage of STEM students who felt they had been well prepared by their A-Levels varies across characteristics such as gender, ethnicity and IMD. Here we see that **the lowest percentages of students agreeing that A Levels prepared them well for degree study are found among women, racially minoritised and the lowest income students.** When we tested for statistical significance, **income and ethnicity** were both significantly associated with feeling prepared for degree study by their A-Levels (whilst gender was not). That is, **white students and middle- and higher- income students felt most prepared by A levels** for their degree study. We also repeated the analysis to look at students who were doing non-STEM subjects at undergraduate level and the patterns were similar but with slightly smaller percentage differences between the groups. For non-STEM students, income and ethnicity were significantly associated with feeling prepared for degree study.

28. To what extent does the current primary curriculum support pupils to study a broad and balanced curriculum? Should anything change to better support this?

In 2023, ASE together with IOP, RSB and RSC, published a report that was developed by an advisory group of primary science experts; and, in 2024, we accepted the recommendations within that report and published the combined report in full: [Developing a Primary Science Curriculum]. Our top line recommendations are that the primary science curriculum should:

a. have a strong emphasis on purpose, considering not just what is taught and learned, but why and how, so that children develop a coherent and cognitively appropriate understanding of how the world works and their own agency within it

b. help children identify with the sciences by providing opportunities for teachers to choose contexts that are relevant to their pupils

c. help all children to feel included in the sciences through the experiences that they have, and the perspectives put on science narratives and by encouraging teachers to use contexts that are familiar to primary age children

d. ensure the curriculum plans for progression to avoid content being taught before it is appropriate for the age/development stage of the child

e. encourage children to think scientifically, to discuss and explain their thinking and, through practical experience, gain a sense of the nature and practices of the sciences

f. Should contain local context and relevance to the students.

29. To what extent do the current secondary curriculum and qualifications pathways support pupils to study a broad and balanced curriculum? Should anything change to better support this?

The dual science route at GCSE (Double / Triple science) hinders progression and exacerbates/ sustains social inequalities, with research suggesting that those who take Triple science are more likely to pursue the study of science post-16, whilst for those taking Double science the likelihood of future participation in science is significantly diminished.

- Archer, L., Moote, J., Francis, B., DeWitt, J. & Yeomans, L. (2016). Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England. *Research Papers in Education*. Published online 29 August 2016, DOI 0.1080/02671522.2016.1219382
- Francis, B. et al. (2023) An exploration of the impact of science stratification in the English school curriculum: the relationship between 'Double' and 'Triple' Science pathways and pupils' further study of science. *Research Papers in Education*.
- ASPIRES 2 Triple science project spotlight. (2018). London: UCL Institute of Education.

Informed by research commissioned by ASE, IOP, the Royal Society, RSB and RSC https://www.iop.org/sites/default/files/2019-06/shiftlearning-science-timetable-models-research.pdf, ASE strongly recommends a single route through the sciences for all students taking GCSEs: a single route that has all the features and benefits of the current "triple science" route whilst not overwhelming and narrowing the curriculum by occupying the time of three full GCSEs, as it currently does. The advantages of this approach, are:

It will prevent the separate sciences being taught at an accelerated rate
It will prevent students being selected for an "elite route" route based on prior attainment and class setting

It will reduce the impression that the sciences are the preserve of high attainers

It will enable all students to study the three sciences separately and increase their access to specialist teachers

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It will prevent high performance in one of the sciences being averaged down in a combined grade

It will provide students with specific information on where their strengths lie

It will improve school accountability and drive the need to recruit and deploy specialist teachers to teach each of the sciences

We recommend that all students taking GCSEs follow a (single) route through the sciences, called "The Sciences", that has the following features for each of the sciences, biology, chemistry and physics:

i. specified and examined separately with its own grade;
ii. timetabled separately with at least two identified lessons;
iii. allocated a separate teacher who is generally a specialist in that science;
iv. designed to prepare students to study A-level in any or all of the sciences, as well as relevant technical pathways.

30. To what extent do the current qualifications pathways at 16-19 support learners to study a broad curriculum which gives them the right knowledge and skills to progress? Should anything change to better support this?

Currently, within the A-level system, students specialise much earlier than they do in most high-performing jurisdictions, such as France and Germany. Whilst this arrangement means that English students start their degrees with a greater breadth of specialised knowledge, the outcomes at the post-graduate level are at a similar level to OECD (2024) international comparisons. This suggests that early specialisation may not offer any apparent benefit to educational outcomes.

There are likely costs to specialising too early. By forcing 16-year-olds to make major decisions on their future study, we create a high-stakes environment that, through mistaken choices at 16, contributes to increasing drop-out rates at both A-level and in undergraduate degrees. Therefore, there is a case to maintain breadth for longer and revisiting the role and assessment of AS levels with the intention of adding breadth and progression opportunities.

As well as providing more breadth, ASE recommends more coherence between science subject, and other subject, combinations and recommend that there needs to be a discussion about the possibility of a more diploma-style qualification at 16 to 19 with a fixed range of pre-defined combinations. For example, there might be a physical science route in which all students study maths, physics, chemistry and computing as major subjects and, in addition, three further (minor) subjects to provide breadth.

The advantages of such a structure are:

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i. Coherence that would arise through links between the major subject areas; for instance, the physics and maths components can build on and relate to each other. And it allows physics (and other subjects) to draw on ideas from maths that are above GCSE level. Additionally, and in a similar way, aspects of other pairs of subjects such as chemistry and computing can build on each other, so broadening and applying learning.

ii. Efficiency and avoiding repetition as a result of any given content being in just one place. For example, mechanics currently appears in both maths and physics; and ideas relating to the kinetic theory of matter appear in physics and chemistry.

32. Do you have any explanations for the trends outlined in the analysis and/or suggestions to address any that might be of concern?

It is important to flag that while some subjects are doing well in terms of some measures (e.g. overall increases in numbers of students taking degree level computing or engineering), these are still highly gender imbalanced – so are not 'thriving' from an equity perspective. Numbers alone are not a sufficient marker of whether a subject is 'thriving'.

33. To what extent and how do pupils benefit from being able to take vocational or applied qualifications in secondary schools alongside more academically focused GCSEs?

There remains a problem with parity of esteem between technical and academic routes. And, as such, students do not really have a free choice. Under the existing system, exams at 16 assess a narrow range of capabilities and act as a filter for choices of further study. Those who succeed in those exams are encouraged onto academic courses – predominantly A-levels - whilst those who do not perform to the required entry standard are guided towards other, often technical, qualifications. Therefore, following a technical route is based more on low attainment in the available academic assessment at 16 than it is on student choice. This maintains the sense that technical routes are the destination for students with lower prior attainment. ASE recommends that students are given more experiences of technical activities up to 16 so that they can make an informed choice.

35. Is the volume of statutory assessment at key stages 1 and 2 right for the purposes set out above?

It is not necessarily the volume of statutory assessment, it is its high stakes nature, leading to skewed practices. In primary science, the removal of statutory testing was necessary to reduce the testing burden, but also because it was not a valid or useful way to measure primary science. Teacher assessment, when supported to do well, can provide more valid summaries of children's attainment, together with supporting teacher practice and formative use of assessment to support children's learning. One of the main reasons that teacher assessment in primary science is not yet working as it should be, is because of the high stakes' nature of the other core subjects. If schools (in league tables) are only judged on English and mathematics, then science will inevitably take a back seat. As a core subject, science attainment should continue to be reported at the end of KS1 and KS2, but teachers need more support in order to make and use judgements in primary science.

36. Are there any changes that could be made to improve efficacy without having a negative impact on pupils' learning or the wider education system?

The main issue with statutory assessment is its high stakes uses, causing schools to place pressure on children and staff to perform for the tests. Removing the league table rating could potentially have more impact than a change to assessment requirements.
Ongoing Teacher Assessment at KS1 and KS2 is important, to pass on to parents/next class teacher and to maintain the profile of science as a core subject. However, the current Teacher Assessment Frameworks are too detailed (containing virtually the whole of the National Curriculum content). A key indicators list might be more effective eg. key concepts in Biology, Chemistry, Physics and Working Scientifically, exemplified by a selection of statements from across the curriculum.
Nevertheless, the most important thing is that teachers have support for making assessment judgements, such as by using the TAPS Focused Assessment approach https://pstt.org.uk/unique-resources/taps/, which enables teachers to select a lesson focus that is appropriate for their class, whilst managing appropriate practical activities in primary science.
Clear curricular guidance needs to be accompanied by exemplification, much of which could be adapted from what has already been collated by the TAPS, Stoke-on-Trent https://data.bathspa.ac.uk/articles/online_resource/Stoke_exemplification_for_primary_science_SEPS_pupil_work_collections/22633456/1
and PLAN https://www.planassessment.com/teacher projects for example. The TAPS project found that opportunities for moderation discussions are an effective means of building shared understanding of attainment expectations and these are a cornerstone of the Focus4TAPS professional learning programme https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/focus4taps that has been found by the EEF to have a positive impact on pupil learning and teacher confidence. Such moderation discussions are not statutory external (and costly) visits, but opportunities to share pupil work with colleagues and discuss 'what a good one looks like'. Such discussions help both formative and summative uses of assessment.

37. Are there other changes to the statutory assessment system at key stages 1 and 2 that could be made to improve pupils' experience of assessment, without having a negative impact on either pupils' learning or the wider education system?

There needs to be a raising of the profile and importance of formative assessment, which is where the difference to learning will happen. In order to be able to have the time to act upon formative assessment information, teachers need to have less statutory content to teach and

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assess. Converting some content into examples for the non-statutory guidance could be one way to support this in the short term. Alternatively, and ASE recommends, a curriculum re-write should draw on the work of the Primary Curriculum Advisory Group, and consult with ASE, IOP, RSB and RSC.

Summaries of attainment/progress are better based on ongoing assessment, to summarise rather than rely on standalone tests, especially for young children who may not be able to access written questions. The TAPS 'formative to summative' model https://taps.pstt.org.uk/ proposes a model of teacher assessment based on a wide range of information as a more valid way to summarise attainment.

38. What can we do to ensure the assessment system at key stages 1 and 2 works well for all learners, including learners in need of additional support in their education (for example SEND, disadvantage, EAL)?

Refocusing assessment to ongoing formative assessment would allow for more practical, hands-on and sensory experiences which are guided, active and purposeful, to support the building of foundational concepts (see the Nuffield practical work project https://www.nuffieldfoundation.org/project/effective-practical-work-primary-school-science).

39. Is the volume of assessment required for GCSEs right for the purposes set out above? Are there any changes that could be made without having a negative impact on either pupils' learning or the wider education system?

- Evidence from "Make it more relevant and practical": Young People's Vision for School Science in England The ASPIRES3 survey found that young people feel that there is too much exam pressure plus E.g. Over half of the young people (52%) called for less exam pressure. Trends within this - young people who wanted less exam pressure were more likely to: · be women and non-binary people · have taken A Level sciences
- Wider evidence of the negative impact on teachers of teaching to the test is found in: Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E & Seakins, A. (2017). Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London Secondary Science Classrooms. *Science Education 101:741–764. https://doi.org/10.1002/sce.21291*

There is a heavy burden of assessment at 16. The existing purposes for assessment are given as 'they assess learning against a defined curriculum, support progression and provide data to hold schools and colleges to account for their performance'. We believe that these purposes are sometimes in tension with each other, are putting too many requirements on assessment, and making those assessments too high-stakes. This high-stakes nature results in schools emphasising exam preparation over quality learning. Decisions are made based on the need to achieve cross-board success in exams, for schools, rather than to maximise the quality or outcomes of learning for individual pupils. Whilst it is important that schools are accountable for

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their outcomes, as well as the quality of their teaching and learning, binding a single measure (exam grade) to both a student and the school has resulted in undesirable effects. These include the loss of the teaching time, with formative assessment, towards the end of year 11 to exams and direct preparation for exams. Up to a quarter of a two-year course may be given over to exams and their preparation. ASE recommends that consideration is given to how the high-stakes nature of GCSE assessments can be lowered, so reducing the time lost to direct preparation for exams, whilst also increasing the range of assessment types, including teacher assessment, to enable students to demonstrate their capabilities in meaningful ways, without impacting on already heavy teacher workloads. Current assessments generally reward those students who are successful in knowledge-based tasks.

40. What more can we do to ensure that: a) the assessment requirements for GCSEs capture and support the development of knowledge and skills of every young person; and b) young people's wellbeing is effectively considered when assessments are developed, giving pupils the best chance to show what they can do to support their progression?

A summative assessment system, based on written exams that comprise a limited number of styles of assessment is not contributing effectively to the stated purposes of assessment. These exams provide a system for producing grades and school rankings; however, it is not providing rich information on all the capabilities a student might have because the assessments test a very narrow range of capabilities. Performance in the assessment provides only limited information about students' strengths and as a result many students do not get opportunities to demonstrate some of their capabilities, because they are not assessed in the current system. This suggests that the students who are most rewarded are those who are successful in knowledge-based tasks. ASE recommends that the curriculum is developed in a principled way based on what is important for students to know and be able to do. Specifications and assessments should then be developed to assess those capabilities, employing digital assessments as appropriate, taking into account teacher assessment, potentially around project work and practical endorsements, without, importantly, adding to the assessment burden and teacher workloads.

On teacher assessment specifically: Assessment needs to be part of how teachers teach every lesson, and enable learners to be proactive in their learning process and recognise where they feel confident and where they need help, and able to ask questions of their teacher, etc. See Cowie. B and Harrison, C 2021 'The what, when, how factors reflections of classroom assessment in the service of Science' https://www.tandfonline.com/doi/full/10.1080/09500693.2020.1824088 , which draws on the ASSIST-ME projects across primary and secondary with many countries. It describes the challenges and the way forward to help teachers include assessment into the pedagogic practice of teaching the science curriculum in diverse classrooms, with teachers in different countries. Formative assessment practice has two strands (divergent and convergent). A stand-alone activity alongside teacher assessment is achieved by observing students, overhearing students talk and asking higher-order thinking questions that stimulate debate and dialogue. Classrooms need both.

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41. Are there particular GCSE subjects where changes could be made to the qualification content and/or assessment that would be beneficial for pupils' learning?

The sciences, generally, as outlined in previous questions, would benefit from a reduction in the volume of content, increased relevance of subject matter to diverse students' identities and lives and a greater emphasis on high-quality practical work which is guided, active and purposeful.

42. Are there ways in which we could support improvement in pupil progress and outcomes at key stage 3?

There is evidence that where teachers have used the Science Capital Teaching Approach it supports wider engagement and students feel the curriculum content is more relevant to their lives. Importance and value of approaches, and space to support teacher critical professional reflection, in order to effect more inclusive teaching and outcomes for socially disadvantaged students:

1. Chowdhuri, M.N., King, H., Godec, S. and Archer, L. (2023) Towards justice-oriented science teaching: examining the impact of the science capital teaching approach on teachers. *London Review of Education*, DOI: https://doi.org/10.14324/LRE.21.1.37
2. Chowdhuri, M.N. and Archer, L. (2023) Getting comfortable with discomfort: supporting primary science teacher educators' capacity for socially just pedagogy. *Journal of Education for Teaching*.
3. Chowdhuri, M.N., King, H. and Archer, L. (2022) The Primary Science Capital Teaching Approach: Building Science Engagement for Social Justice. *The Journal of Emergent Science*, 23: 34-38.

44. To what extent, and in what ways, does the accountability system influence curriculum and assessment decisions in schools and colleges? (school performance measures sharing)

The negative impact on student uptake of subjects perceived as difficult, of grade severity in A level marking especially in physics has been noted by various organisations, including the IOP and FFT. E.g. Why A-Level physics students are doubly penalised by grading severity - FFT Education Datalab

45. How well does the current accountability system support and recognise progress for all pupils and learners? What works well and what could be improved? (school performance measures sharing)

Performativity is associated with negative outcomes and impacts for both students and teachers, encouraging 'teaching to the test' which reduces engagement and interest among students and is negatively experienced by staff:

1. Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E & Seakins, A. (2017). Killing curiosity? An analysis of celebrated identity performances among teachers

and students in nine London Secondary Science Classrooms. *Science Education 101:741–764.* https://doi.org/10.1002/sce.21291

2. "I'll be a nothing": structure, agency and the construction of identity through assessment (Reay and Wiliam, 1999, British Educational Research Journal)

52. How can the curriculum, assessment and wrap-around support better enable transitions between key stages to ensure continuous learning and support attainment?

ASPIRES evidence points to the importance of designing educational practice that can support and build student identity and capital in relation to subject areas, but particularly among those from under-represented communities. Evidence suggests that less privileged students receive less high-quality extra curricula support too. Evidence on the role of capital is detailed in publications such as:

- ASPIRES3 Mathematics.pdf
- Becoming exceptional: the role of capital in the development and mediation of mathematics identity and degree trajectories
- Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., Nomikou, E. & Seakins, A. (2017) Using Bourdieu in practice? Urban secondary teachers' and students' experiences of a Bourdieusian-inspired pedagogical approach. *British Journal of Sociology of Education.* Published online http://dx.doi.org/10.1080/01425692.2017.1335591.
- Archer, L. (2017) Happier teachers and more engaged students? Reflections on the possibilities offered by a pedagogical approach co-developed by teachers and researchers. *Research in Teacher Education*, 7(1): 29-32.
- Holmegaard, H.T., Archer, L. et al (2024) Feeling the weight of the water: a longitudinal study of how capital and identity shape young people's computer science trajectories over time, age 10–21. *Computer Science Education*

If changes are made to curricula in one or both phases, it is essential to consider progression and continuity of language and concepts. If KS2 and KS3 curricula, for example, are developed and written separately, they risk exacerbating the primary-secondary 'divide'.

54. Do you have any further views on anything else associated with the Curriculum and Assessment Review not covered in the questions throughout the call for evidence?

Setting practices that are driven by accountability and assessment regimes are highly problematic – are these within the scope of the review? Evidence sources:

1. Archer, L., Francis, B., Miller, S., Taylor, B., Tereschenko, A., Mazenod, A., Pepper, D., and Travers, M-C. (2018) The symbolic violence of setting: A Bourdieusian analysis of mixed methods data on secondary students' views about setting *British Educational Research Journal, 44(1): 119-140* https://doi.org/10.1002/berj.3321

2. Francis, B., Craig, N., Hodgen, J., Taylor, B., Tereschenko, A., Connolly, P. & Archer, L. (2020) The impact of tracking by attainment on pupil self-confidence over time: an accumulative self-fulfilling prophecy. *British Journal of Sociology of Education.* https://doi.org/10.1080/01425692.2020.1763162
3. Francis, B., Archer, L., Mazenod, A., Craig, N., Taylor, B., Tereschenko, A., Hodgen, J. & Connolly, P. (2019) Teacher 'quality' and attainment grouping: the role of within-school teacher deployment in social and educational inequality. Teaching and Teacher Education, DOI: 10.1016/j.tate.2018.10.001
4. Tereshchenko, A., Francis, B., Archer, L., Hodgen, J., Mazenod, A., Taylor, B., Pepper, D., Travers, M-C. (2019) Learners' attitudes to mixed-attainment grouping: Examining the views of students of high, middle and low attainment. *Research Papers in Education* 34:4, 425-444, DOI: 10.1080/02671522.2018.1452962
5. Connolly, P., Taylor, B., Francis, B., Archer, L., Hodgen, J., Mazenod, A. & Tereshchenko, A. (2019) *The misallocation of students to academic sets in maths: A study of secondary schools in England.* British Educational Research Journal. https://doi.org/10.1002/berj.3530
6. Taylor, B., Francis, B., Craig, N., Archer, L., Hodgen, J., Mazenod, A., Tereshchenko, A., Pepper, D. (in press) Why is it difficult for schools to establish equitable practices in allocating students to attainment 'sets'? *British Journal of Educational Studies*.
7. Mazenod, A., Francis, B., Archer, L., Hodgen, J., Taylor, B., Tereshchenko, A., Pepper, D. (2018). Nurturing learning or encouraging dependency? Teacher constructions of students in lower attainment groups in English secondary schools. *Cambridge Journal of Education*.

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