Royal Society of Chemistry (RSC) Response to the Call for Evidence on People and skills in UK science, technology, engineering and mathematics

With around 45,000 members and a knowledge business that spans the globe, the RSC is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world. Our members include those working in large multinational companies and small and medium enterprises, researchers and students in universities, teachers, and regulators. Our Royal Charter aims include: "*to establish, uphold and advance the standards of qualification, competence and conduct of those who practise chemistry as a profession".*

This response covers the questions in the Call for Evidence where we can provide evidence and recommendations from our research and/or the chemical sciences community. As a Professional Body and Learned Society, we also have an important role to play in ensuring the UK has the people and skills needed in STEM, for example through supporting members' continuous professional development of STEM and other skills and knowledge, supporting chemistry teachers, bringing chemical scientists together, disseminating knowledge and researching and campaigning on key issues for our science, such as inclusion and diversity in the chemical sciences.

Q1 International Talent

The UK immigration system must be flexible, low cost, and light-touch, as well as adopting a welcoming tone and attitude, so that UK science can continue to thrive and attract talent from all over the world. However, current UK migration routes for people with STEM skills have inherent problems. The Post-Study Work route is valuable, particularly for retaining researchers post doctorate, but does not allow for individuals to go home before applying. The High Potential Individual visa has overly narrow eligibility based on untransparent university league tables and does not recognise the applicant's future potential.

The UK visas needed to recruit globally, including the Global Talent visa and the Innovator and Scale-Up visa, are expensive. Analysis on visa costs carried out in 2019 by the Royal Society[1] shows that the UK has some of the highest upfront costs in the world for immigrating scientists and their sponsors. In October 2020, the Immigration Health Surcharge, the biggest component of the upfront costs, increased by more than 50%, further widening the gap between the UK and other leading science nations. These costs are the most significant barrier as many individuals, especially if accompanied by their family, cannot afford them. They are also prohibitive to SMEs, with half of small businesses saying they cannot afford visa sponsorships[2]. This stops innovative SMEs bringing in international STEM talent despite the government's rhetoric on attracting the 'best and brightest'.

Evidence is emerging that it has become harder to retain and attract international talent in chemistry research. Prof Roel Dullens, previously at Oxford Chemistry, moved his entire research group to Nijmegen once UK association to Horizon Europe looked unlikely[3]. We hear the field of chemical physics/physical chemistry is seeing some talented early career scientists move away from the UK. Some UK chemists have also reported increased difficulties in recruiting post-doctoral researchers.

Q2 STEM Skills

In common with many other STEM and other fields, digital and sustainability skills and knowledge are becoming increasingly important in the chemical sciences. The RSC's Digital futures report[4] shows the growing role and importance of digital chemistry skills. In the biopharmaceutical sector, a significant employer of chemists and chemistry skills, recent research shows a need for more candidates with digital skills. It also sets out the need to address specialist chemistry skills gaps in for

example formulation science, computational chemistry (including chemoinformatics), pharmacokinetic/ pharmacodynamics modelling and engineering in manufacturing[5]. Additionally, practising chemists working in academia and industry report a gap between chemical scientists' current skills and knowledge and those needed for green jobs now and in the future. 94% of those who identified a gap said it is at least moderately significant[6].

Both postgraduate and technical and vocational chemistry education need to equip students for business careers. Postgraduate education must contribute to broad skills development to prepare individuals for a diverse range of careers in and beyond academia. While postgraduate research training is a valuable route to develop the academic scientific workforce, figures from the Engineering and Physical Sciences Research Council (EPSRC) show that only 35% of EPSRC-funded doctoral graduates continue their career in academia[7]. Research training models should help students learn a broader mix of skills to equip them for research, innovation and leadership roles, including outside of academia.

Research into chemistry intensive SMEs has revealed that a lack of business and leadership skills can be a barrier to company growth and productivity[8]. The Engineering and Physical Sciences Research Council's recommendation that **all students "should have access to opportunities outside of their research project"[9]** could enable broader skills development, which likely will pay dividends to the UK economy as we make headway on the government's goal to become a leader in innovation and research commercialisation.

It is equally important to consider technical and vocational pathways. For some time we, along with biology and physics professional bodies, have called on the Institute for Apprenticeships and Technical Education (IfATE) to address our concerns regarding the knowledge requirements in some apprenticeships, including the laboratory technician. IfATE has removed the safeguards that protected the minimum level of knowledge required to be taught in this apprenticeship, which means it is now entirely possible for an apprentice to complete this programme and not be taught fundamental scientific principles, such as the periodic table. **Ensuring a link between skills and knowledge in apprenticeships is essential.** Within the chemical sciences the need for knowledge and the link to application of knowledge using skills is vital, for example to know the consequences of actions in unknown circumstances, which can inherently link to health, safety and environmental impact. Also, a knowledge base prepares people for future as well as current challenges.

We strongly support apprenticeships, welcome the introduction of T Levels and advocate the need for more people to be undertaking Higher Technical Qualifications. About 25,000 learners take Applied Science qualifications each year, and it creates a valuable route into the sciences. **We are calling on the government to properly evaluate the potential impact of the removal of funding for chemistry and other STEM subjects – and give time for T-levels to embed – before taking further decisions about funding of Applied Science qualifications.** Removing the funding for these learners before the T Level is fully embedded and able to accommodate this volume of learners, presents the risk that some individuals who aspire to progress within the sciences will not have a route available to them.

Q3 Education sector

Teacher recruitment and retention: The number of people training to become chemistry teachers is frequently below DfE targets and the situation is considerably worse for physics[10]. Analysis predicts an inadequate supply of STEM teachers in England from 2022 to 2025[11]. Science teacher shortages are also prevalent in Wales[12] and Scotland[13].

Recruitment and retention of chemistry teachers is more challenging than for many other subjects, in part because teacher salaries do not compare favourably to the earning potential of STEM graduates[14]. Financial incentives have a role to play in attracting and retaining chemistry teachers[15], but Governments should regularly evaluate their effectiveness and value for money. '**Workload' is the most cited reason for teachers leaving the profession**[16]. Addressing this would help retain the current workforce and make it a more attractive career option for new entrants and returners.

Relative differences in teacher shortages between the sciences affects how schools deploy science teachers,[17] with teachers often[18] deployed outside of their 'specialist' science discipline (e.g. biology graduates teaching chemistry). Schools with higher proportions of students eligible for free school meals and those in the most deprived areas are less likely to have science teachers with a qualification relevant to the main science discipline they teach[19]. This is a problem because the most effective teachers have good subject and pedagogical content knowledge [20] and passionate expert teachers of chemistry can influence students' decisions to pursue a STEM related career or further study.

To ensure there are enough experts teaching the sciences and address the relative differences in shortages between the disciplines, **teachers must be supported to develop and, where appropriate, expand their subject and pedagogical content knowledge**. This includes professional development to help teachers with a background in one science discipline gradually gain the expertise needed to teach curriculum content in one or both other school science disciplines confidently and with passion.[21]

Encouraging people from all backgrounds into STEM education: Social and economic inequalities are limiting the aspirations and career choices of some young people and affecting progression to further study or employment in chemistry[22]. **We recommend government reassess long-standing barriers in education** such as grading severity, inequality embedded by dual routes of study e.g. separate science vs double award GCSE, inaccessibility and confidence.

Also, we have significant concerns that students, teachers and career guides do not understand the careers opportunities chemistry can offer, which may impact student entry numbers to further study and careers. **We recommend that young people should understand the value of chemistry to society and to their future careers. This should be embedded in the curriculum as an expected learning outcome**, and teachers supported with resources and ongoing professional development opportunities. Our recent Green Shoots Report showed that while young people are interested in future careers or study relating to sustainability, only 38% felt that studying chemistry can lead to lots of jobs in sustainability and climate change[23]. **We call on governments to ensure young people have the skills and careers information needed to progress into green jobs in the chemical sciences and contribute to the future green economy**.

Q4 Quality of Academic Careers

Improving the attractiveness of academic careers will require improving working conditions for researchers; addressing structural barriers related to the funding system; and developing a more positive and inclusive academic culture. Delivery of the Government's R&D people and culture strategy should remain a priority.

A recent report on 'Reducing the precarity of academic research careers' by the OECD describes the contextual determinants of precarity in research careers as "the worsening working conditions for researchers due to changes in the conduct of research, in the supply and demand for doctorate holders, and in research careers, further compounded during the Covid-19 crisis"[24]. In the UK, the issue of low remuneration for researchers has been raised by the government,[25] and pension cuts have worsened researchers' dissatisfaction[26]. The OECD report shows that reducing precarity will require a range of

interventions[27]. We welcome UK Research and Innovation's announcement that it will raise its minimum stipend from 1 October to reflect the cost of living increases and **we call on Government and funders to consider urgently how to support PhD students and other researchers most impacted by the cost of living crisis**.

Issues with the culture of research in the UK have been highlighted by several organisations in the research sector in recent years[28]. The government's R&D people and culture strategy seeks to address many of these issues, and delivery of this strategy should remain a priority.

RSC research into the structural barriers to inclusion of women and minoritised ethnicity scientists identified an unsupportive academic culture, unequal access to funding and narrow definitions of success as systemic barriers to the retention and progression of these groups. Key actions to tackle these barriers are:

i. **Encourage and support filling gaps in evidence, monitoring and reporting** – we need greater transparency to enable the sector to learn lessons and share best practice.
ii. **Address inequalities in funding, reward and recognition** – there are continued inequalities in salary and reward across academia and industry, and funding systems present structural barriers for underrepresented groups. The RSC has conducted research and suggested actions for funding bodies, with broader applicability in some cases, for example the need to review and expand definitions and measures of success and excellence in STEM.
iii. **Provide greater flexibility and adjustments** – these are key factors in enabling equal participation for those from underrepresented groups. Existing support provisions, such as Access to Work and Disabled Students' Allowance, should be reviewed to ensure necessary support is in place and fit for purpose.
iv. **Increase accountability; eliminate bias, bullying and harassment; and build cultures of belonging** – creating diverse, inclusive and welcoming STEM workplaces requires intervention at all levels. The RSC has conducted extensive research here and developed recommendations to tackle exclusionary behaviour, increase accountability for bullying and harassment, address implicit bias and mitigate its effects, and remove barriers to underrepresented groups' equal participation and sense of belonging.
v. **Tackle inequalities in education** – as set out in our response to Q3, long-standing barriers to access to high quality science education need to be addressed to ensure that every student, whatever their background, receives an excellent chemistry education.
vi. **Shift the burden** – Throughout these recommendations, it must be ensured that those from underrepresented groups are not being burdened with unrecognised work to combat their own underrepresentation. Our Report on race and ethnicity inequalities in the chemical sciences also emphasises the impact of this 'representation fatigue'.

Further detail on these areas is set out in our response to the recent Commons Science and technology committee inquiry on inclusion and diversity in STEM.

Contact: The Royal Society of Chemistry would be happy to discuss any of the issues raised in our submission in more detail. Please contact policy@rsc.org.

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