Written Evidence Submitted by the Royal Society of Chemistry (DIV0032)

1. Introduction

With about 45,000 members in over 100 countries and a knowledge business that spans the globe, the Royal Society of Chemistry (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 to medium enterprises, researchers and students in universities, teachers and regulators.

We welcome the opportunity to respond to this inquiry, considering the following terms of reference:

- The nature or extent to which women, ethnic minorities, people with disabilities and those from disadvantaged socioeconomic backgrounds are underrepresented in STEM in academia and industry *(see section 4)*;
- The reasons why these groups are underrepresented *(see section 5)*;
- The implications of these groups being underrepresented in STEM roles in academia and industry *(see section 6)*;
- What has been done to address underrepresentation of particular groups in STEM roles *(see section 7)*; and
- What could and should be done by the UK Government, UK Research and Innovation, other funding bodies, industry and academia to address the issues identified *(see section 8)*.

A core principle underpinning the work of the RSC is our belief that for the chemical sciences to prosper, they must attract, develop and retain a diverse range of talented people. Inclusion and diversity is a pillar of our organisational strategy [14]. As a professional and membership body, and a leading voice for the chemistry community, we have a responsibility to promote inclusivity and accessibility in order to improve diversity. We take an evidence and data-based approach, listen to the lived experiences of our communities and act. We have designed and developed multiple interventions to drive change in the culture of chemistry and its ethical practice.

2. Summary of submission

Section 4: Sets out evidence on the underrepresentation of certain groups in the chemical sciences, with data collected from our research into the barriers facing women; people from minoritised ethnic backgrounds; disabled people; people from disadvantaged socio-economic backgrounds; and LGBT+ people. This draws on our 2018 report Diversity landscape of the chemical sciences [2], which showed that the chemical sciences are not representative of society as a whole, in particular with regard to disability, ethnicity, sexual orientation, socioeconomic background and gender and subsequent research.

Section 5: Sets out the evidence on the reasons why particular groups are underrepresented, including barriers to retention and progression; reward gaps and job satisfaction considerations; structural barriers in research and funding systems; higher education inequalities; bullying, harassment, and cultures of not-belonging; implicit bias and exclusionary environments; and barriers to progression from compulsory education.

Section 6: Sets out evidence on the implications of the underrepresentation of these groups in chemistry and in STEM more broadly, including negative impacts on the quality of science and innovation, economic recovery, and our ability to address global challenges, such as progressing the UN Sustainable Development Goals.

Section 7: Examples of the work that the RSC is undertaking and participating in to address underrepresentation in the chemical sciences. These include work to understand the experiences of underrepresented groups, funding and programmes to tackle these, as well as our review of reward and recognition and our bullying and harassment helpline.

Section 8: Sets out our recommendations that the UK Government, UKRI, other funding bodies, industry and academia need to address the following:

i. Address gaps in evidence, monitoring and reporting – we need greater transparency in reporting equalities data 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 has developed a number of suggested actions for funding bodies, with broader applicability in some cases; a key example is the need to review and expand definitions and measures of success and excellence in STEM.

iii. There needs to be greater flexibility and adjustments – flexibility and adjustments 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 as part of ensuring that necessary support is in place and fit for purpose. Those with chronic energy-limiting conditions need greater support and consideration, and this area will only become more relevant in light of 'long Covid'.

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 in this area and has 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. Inequalities in education – 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. Shifting 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.

3. General comments

3.1 Language

i. We use "disabled people" in recognition of a social model approach to disability which notes that people with physical and/or mental impairments or differences are *disabled by* an inaccessible society; 'disability' is created in the interaction with society, rather than being a characteristic or appendage of an individual as suggested by "people with disabilities".

ii. We use "people from minoritised ethnic backgrounds" or "people of minoritised ethnicities" for a similar reason; to highlight that particular racial or ethnic backgrounds are not inherently, or even numerically, 'minority' but that dependent on geographical/historical/social contexts some people are *minoritised* on the grounds of their racial or ethnic background.

3.2 Scope

i. We note that the terms of reference for this inquiry do not include specific reference to LGBT+ people. As our data and evidence shows, LGBT+ individuals are a group facing significant barriers to representation, progression and retention in STEM.

ii. Our 2019 report *Exploring the workplace for LGBT+ physical scientists* [7] gathered data and evidence on the experiences of LGBT+ individuals in the physical sciences (i.e. physicists, astronomers and chemical scientists) and the barriers to their retention and career progression. The report shows that STEM workplace policies and procedures do not adequately support employees who are not heterosexual and cisgender.

iii. 18% of LGBT+ physical scientists have personally experienced harassment or other exclusionary behaviour at work. Trans and non-binary respondents experienced the highest level of exclusionary behaviour.

iv. 28% of LGBT+ respondents stated that they had at some point considered leaving their workplace because of the climate or discrimination towards LGBT+ people. Nearly half of trans respondents had considered leaving their workplace because of the climate, with almost 20% of them considering this often.

v. 49% of all respondents, including non-LGBT+ respondents, agreed there was an overall lack of awareness of LGBT+ issues in their workplace.

3.3 Intersectionality

i. Much of our evidence is presented according to identity-specific categories and backgrounds one at a time; however, the importance of an intersectional approach must be underlined. Our evidence consistently demonstrates that, for individuals belonging to multiple under-represented groups, experiences of exclusion can be compounded, and/or can differ in nature from that experienced by others belonging to each of those groups individually. This can result in the dismissal of experiences which are not seen as fitting in with 'typical' experiences of exclusion. It is vital that these intersectional experiences are attended to when working to address under-representation, so as not to fall into a 'one size fits all' model of inclusion and diversity work which can then itself become exclusionary.

4. The nature or extent to which women, ethnic minorities, people with disabilities and those from disadvantaged socioeconomic backgrounds are underrepresented in STEM in academia and industry

4.1 Overview

i. Our 2018 report *Diversity landscape of the chemical sciences* [2] showed that the chemical sciences are not representative of society as a whole, in particular with regard to disability, ethnicity, sexual orientation, socioeconomic background and gender. We identified themes of mental health and disability, ethnicity, sexual orientation, socioeconomic background and gender where improvements in equality and inclusivity are needed.

4.2 Diversity in our membership and the chemical sciences

i. Our *Diversity data report 2020* [1] presents diversity data from across our membership and organisational activities – including governance bodies, prizes, grants, education, publishing. The chemical sciences community, particularly that in the UK, is reflected in our membership.

ii. The demographics of our largest membership category (MRSC or 'Member') are listed below with the UK population benchmark percentage (details on population data are available in our Diversity data report 2020 [1] – page 7, footnotes) indicated in brackets for comparison:

  - **Gender identity**: 25% (50.6%) female, 75% (49.4%) male, <1% self-described;
  - **Ethnicity:** 7% (6.9%) Asian, 3% (3%) Black, 1% (2%) mixed, 1% (0.9%) other, 87% (87.2%) White;
  - **Disability:** 91% (78%) not disabled, 9% (22%) disabled;
  - **Sexual orientation:** 2% asexual, 2% bisexual or pansexual, 2% gay man, <1% gay woman/lesbian, 93% heterosexual/straight, 1% self-described;
  - **Age**: 4% (36.4%) age 29 or under, 28% (19.3%) ages 30-44, 32% (20.2%) ages 45-59, 25% (15.6%) ages 60-74, 11% (8.5%) age 75 and over.

iii. As membership categories are in part reflective of an individual's career progression in the chemical sciences, we see variances in demographics including age. The diversity of our overall membership has increased over time as observed by the demographics broken down by length of membership. For example, for members of five years or less the gender breakdown is 39% female and 61% male, compared to members of over 30 years where the gender breakdown is 9% female and 91% male. A similar trend is seen for diversity in ethnicity.

iv. However, the representation of various groups within our membership continues to be disproportionate to UK population comparisons, evidencing the continued underrepresentation of women, disabled people, LGBT+ people, and people from minoritised ethnic backgrounds (with Black people even more starkly underrepresented) i the chemical sciences.

4.3 Women

i. Our *Diversity landscape* [1] showed a clear lack of progress in the retention and progression of women in the chemical sciences. We showed that gender inequality is particularly prominent in STEM, and that there is a high rate of attrition of women throughout the academic chemical sciences career path. We reported that, as of 2018:

  - The proportion of women continuing to postgraduate study drops from 44% at undergraduate level to 39% at postgraduate level across the whole physical sciences cohort, and to 35% for UK domiciled postgraduate students. The gender balance at postgraduate level has remained virtually unchanged over the last 10 years.
  - Retention and development of women into senior roles remains poor in the chemical sciences. The numbers drop off at each stage of the academic career ladder and chemistry within higher education becomes increasingly male dominated at senior levels. At professorial level, the representation of

women falls to only 9% – even lower than physics, where even though 20% of undergraduates are female, 10% of professors are female.

  - The most recent available data showed that only 18.4% of permanent contract holders in chemistry in academia are women.

ii. Following the evidence of gender inequality in the chemical sciences from the Diversity landscape report, our 2018 report *Breaking the barriers* [6] focused on understanding the barriers to women's retention and progression in the chemical sciences, focusing on academic career paths.

  - 99% of the women who responded to this research said that they could evidence a lack of retention and progression of women in the chemical sciences in academia.
  - 74% of respondents working in industry have seen evidence of the lack of progression and retention of women outside academia.

4.4 People from minoritised ethnic backgrounds

i. Our analysis of ethnicity for UK academic chemistry using HESA 2019/20 data for students and staff shows that there is an under-representation of people from minoritised ethnic backgrounds through academic progression in chemistry, which is particularly pronounced for Black chemists.[1]

ii. Although Black students are well-represented at the undergraduate level compared to the UK population, there is a significant point of attrition from undergraduate (4.8%) to PhD (1.4%) studies. This drops even further through the academic pipeline, to 0.9% non-professorial staff and 0% professors who are Black.[2] Across all STEM subjects, the attrition of Black people is observed later, after postgraduate level into academic employment [30]. In chemistry, we are losing Black students earlier as compared to the rest of STEM.

iii. The HESA data also show that there has been no significant increase in Black representation across the UK chemistry academic pipeline in the last 10 years. The only exception is a small increase in undergraduate students (from 4% in 2010/11 to 5% in 2019/20). However, representation at postgraduate, non-professorial and professor staff levels has remained stagnant since 2010.

iv. The data are clear for UK academic chemistry, but the problem of under-representation extends to other sectors beyond academia. RSC membership, which is comprised of chemical scientists worldwide and in a diverse range of sectors, also shows the under-representation of Black individuals. The membership categories Associate, Member and Fellow tend to correlate with career progression, and Black representation decreases in this same order of seniority (respectively, 14.3%, 3.1% and 1.7%), indicative of the attrition of Black people from the chemical sciences [1].

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[1] This data analysis will be published in our upcoming report focusing on race and ethnicity inequalities in the chemical sciences, the findings of which were partially presented at our 2021 Inclusion and Diversity Forum. Similar findings from our analysis of 2017/18 HESA data are publicly available [9].

[2] Note that, according to HESA anonymisation methodology, numbers fewer than 2.5 are rounded down to zero and will result in a percentage calculation of zero.

4.5 Disabled people

i. Understanding and tackling the barriers faced by disabled chemists has been a priority area for the RSC in 2021 and continues to be a priority area in 2022. Disabled people are under-represented in RSC membership and activities, as compared to the UK population; just 9% of RSC members (MRSC category), 2% of editors, and 0% of prize winners self-report as having a disability [1]. We do not yet have comparison data to understand the extent to which this is directly reflective of the chemical sciences sector.

ii. Terminology, disclosure and self-identification have significant influence on data around the representation of disabled people: for example, in a Wellcome Trust survey, differently phrased questions elicited self-reporting of disability at 6%, 13% or 32% [43]. These differentials make disabled underrepresentation more difficult to gauge than underrepresentation in some other areas.

4.6 People from disadvantaged socio-economic backgrounds

i. Currently there is a lack of clarity, consensus and understanding of good practice measures of socio-economic background. As this is not a legally protected characteristic in the UK, higher education institutions and/or organisations often have limited data related to socio-economic status *(see 8.5.i)*.

ii. Our 2020 report *Chemistry for All* [8] is the result of a five-year research study about the impact of an outreach programme on school students' attitudes towards and progression in chemistry. The report analysed UCAS data to investigate the socioeconomic family background make-up of chemistry undergraduates compared to all undergraduate subjects and to the wider UK population. The report showed that:

- Social and economic factors widen the participation gap in chemistry. Students from socioeconomically advantaged backgrounds are more likely than socioeconomically disadvantaged students to study chemistry at undergraduate level.
- The most advantaged group, with family backgrounds in higher managerial and professional occupations, makes up 32.2% of undergraduate chemistry students, while the least advantaged group, with family backgrounds in routine occupations, numbers less than a fifth in comparison (6.1%), despite occupying more of the total UK population (11.8% most advantaged vs 13.3% least advantaged).
- This socioeconomic gap found in chemistry undergraduate students is also wider than that found in all undergraduate subjects between the most and least advantaged groups (22.9% vs 8.0%, respectively).

iii. One of our 2022 priorities is to further investigate the influence on access and retention in chemistry considering socioeconomic background intersected with diversity characteristics. As indicated elsewhere *(see 3.3, 4.7)*, an intersectional approach is imperative. This is especially true when considering socioeconomic background, in order to ensure that people from socioeconomically disadvantaged backgrounds are understood as an internally diverse group, and prevent any placing of this group in perceived competition for attention with other underrepresented groups.

4.7 Intersectionality

As already addressed *(see 3.3)*, for those belonging to multiple underrepresented groups an intersectional approach is needed.

i. Exemplary of this necessity, our evidence demonstrates differences in experience of underrepresentation for those at the intersection of ethnicity and gender. Our HESA data analysis revealed that women of all ethnicities tend to leave academic chemistry after PhD level, but this attrition is most marked for Black women.[3]

ii. There are significant differences in gender breakdown at undergraduate and PhD chemistry level according to ethnic background.[4] For White students, there is a male majority at undergraduate (42.4% F / 57.6% M) and PhD* (36.7% F / 63.0% M) levels. For Asian students, the gender distribution is more even at both levels (48.2% F / 51.8% M and 48.6% F / 51.4% M, respectively). For Black students, there is instead a female majority at both levels (60.6% F / 39.4% M and 57.1% F / 42.9% M, respectively).

iii. This picture changes after chemists complete their postgraduate studies, with fewer women progressing to non-professorial staff and further to professors, regardless of race or ethnicity. The progression beyond postgraduate studies to non-professorial staff (White 31.8% F, Asian 28.6% F, Black 16.7% F) and further to professors (White: 13.2% F, Asian: 16.7%, Black: zero female or male professorial staff[5]) shows significant attrition of all female chemists. However, the loss of women is most pronounced for Black women.

5. The reasons why these groups are underrepresented

Understanding the underrepresentation of particular groups in STEM requires attention to complexly intersecting factors at multiple levels – from the individual through the institutional to the structural and societal. Although bias, discrimination and exclusionary behaviour on the individual interpersonal level is an important part of the picture *(see 5.5-5.7)*, our evidence demonstrates the necessity of understanding and intervening in the structural barriers that contribute to underrepresentation *(see 5.1-5.4)*.

5.1 Barriers to retention and progression

i. Our upcoming report on race and ethnicity inequalities includes evidence gathered from new qualitative research on the lived experiences of hundreds of people from minority ethnic backgrounds working in chemistry globally. Although these factors are drawn from our research focusing on the underrepresentation of chemists from minoritised ethnic backgrounds specifically, they are also widely applicable to other underrepresented groups and indicative of what we believe to be key areas of concern when understanding the reasons behind the underrepresentation of particular groups in STEM.

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[3] This data analysis will be published in our upcoming report focusing on race and ethnicity inequalities in the chemical sciences, the findings of which were partially presented at our 2021 Inclusion and Diversity Forum. Similar findings from our analysis of 2017/18 HESA data are publicly available [9].

[4] Note that the HESA student dataset also contains Gender: "Other" but these numbers were statistically insignificant and are omitted from this analysis, except for 0.3% Gender: Other of White PhD Students.

[5] Note that, according to HESA anonymisation methodology, numbers fewer than 2.5 are rounded down to zero and will result in a percentage calculation of zero.

ii. The evidence suggests there are six interacting factors that impact retention and success for chemists who identify as Black or from another minoritised ethnic background:

1. **Attraction, inspiration and progression**. This includes a lack of role models, limited chemistry-related careers guidance and support, and short-term approaches to outreach.
2. **Mentorship, sponsorship and networks**. This includes more limited access to advice, networks and opportunities, and the need for a more consistent, institution-wide approach to support.
3. **The culture of chemistry** *(see also 5.4.4)*. This includes implicit and explicit racism and exclusion as well as the wider challenges of a chemical sciences culture that is often competitive, hierarchical and inflexible.
4. **Funding systems and structural barriers** *(see also 5.3)*. This includes a lack of equal access to research experience at earlier stages and, later, unequal access to funding, as well as narrow definitions of success that penalise people who take less traditional paths.
5. **Global community**. This includes a focus on collaboration with other countries in the Global North, leading to missed opportunities to collaborate with the diverse range of talent in the with the Global South chemical sciences community.
6. **Leadership in the community, accountability and allyship** *(see also 5.5-5.6)*. This includes the need for stronger institutional and sector-wide leadership and accountability on racism, inequality and discrimination, as well as for individuals to be more willing to talk about and tackle these issues at work.

5.2 Reward and job satisfaction

Gaps in salary and reward, as well as differing experiences of workplace environments and job satisfaction, create a feedback loop that is both caused by and perpetuates the underrepresentation of particular groups. Our 2021 report on Pay and Reward in the chemical sciences [13] showed that:

i. Gender

- The gender pay gap still exists, with women having a lower median salary (£40,000 full-time) than men (£51,000 full-time), as well as a lower median annual bonus (£2,200 vs £5,300).
- Women are less likely to agree that their pay is fair and also less likely to say that their current job provides a level of income they are happy with.

ii. Race and ethnicity

- Respondents from minoritised ethnic backgrounds have a lower median salary (£41,000 full-time) than White respondents (£47,000 full-time), as well as a lower median annal bonus (£2,100 vs £4,000).
- Chemists from minoritised ethnicities are significantly less likely to agree that their pay is fair and significantly less likely to say that their current job provides a level of income they are happy with, compared with White chemists.
- 4% of respondents from a minoritised ethnic group reported being unemployed, compared to 1% of White respondents.

- 20% of respondents from a minoritised ethnic group are on a fixed term contract, compared to 7% of White respondents (although this may be related to the relative overrepresentation of respondents from minoritised ethnic groups in academia vs outside academia).

iii. *Disability*

- Disabled chemists face some particular barriers. Disabled respondents were less likely than non-disabled respondents to hold positions with a high responsibility, with only 21% of disabled respondents hold a position of high responsibility compared to 37% of non-disabled respondents.
- The data showed that disabled chemists have a lower median salary (£41,500 full-time) than chemists who did not self-identify as disabled (£49,000 full-time), as well as a lower median annal bonus (£3,000 vs £4,600).
- Disabled respondents were significantly less likely to agree that their pay is fair and significantly less likely to say that their current job provides a level of income they are happy with, compared with respondents who did not self-identify as disabled.
- Findings also suggest that disabled respondents may be more likely to feel unfulfilled compared to non-disabled respondents. They are less likely to consider their job challenging or stimulating, and less likely to say their current job makes full use of their skills. They are also less likely to have access to learning and development opportunities to help them perform in their current role or progress in their career.
- Disabled respondents also appear to have faced particular difficulties in maintaining and developing their skills as a direct impact of the COVID-19 pandemic. 21% of disabled respondents reported they had been affected by this, compared to 9% of non-disabled respondents. They are also less likely to feel secure in their current job.

iv. *Career breaks*

- Of those who take career breaks, 13% of respondents feel their prospects are better as a result, 42% feel they are worse, and 45% feel they are unaffected. However, what is concerning is the disparity between how different groups perceive they are affected by career breaks, with women and disabled respondents feeling they are more adversely affected. This is possibly affected by the type of career breaks these respondents take, with breaks for parental leave and health reasons being viewed more negatively than breaks taken for travel or study.

v. *Workplace environment (see also 5.5-5.7)*

- LGBT+ respondents, disabled respondents, women respondents, and respondents from minoritised ethnic groups in the UK are less likely than their counterparts to agree that there are equal opportunities for all employees where they work; that they feel proud to work for their current employer; that they would recommend their employer as a great place to work; and that they feel their working environment is diverse and inclusive. LGBT+ respondents, disabled respondents, and respondents from minoritised ethnic groups in the

UK are also less likely than their counterparts to agree that they feel able to be themselves at work.

5.3 Structural barriers in research and funding

Our 2018 report *Breaking the barriers* [6] examined the barriers to women's retention and progression in the chemical sciences, focusing on academic career paths. Three key barriers were uncovered, all of which apply to men as well as women, but which disproportionately impact upon women academics in the chemical sciences. Furthermore, wider evidence demonstrates that these barriers impact disproportionately on other underrepresented groups as well as women. In particular, while data on disabled people in STEM is more scarce than for some other groups, we note that academic funding structures and a lack of flexible working are particularly impactful for disabled scientists [43].

i. *Academic funding structures*
    - The dominance of short-term contracts, and high competition for funding, creates unnecessary pressure and uncertainty. 83% of UK female academics said that over-reliance on short-term funding impacted on the progression and retention of women.
    - Funding eligibility criteria can be arbitrary and can limit opportunities instead of creating them.
    - Definitions of success are based on a narrow understanding of excellence, and skewed towards a 'publish or perish' mentality.
    - There is a lack of recognition in funding decisions for non-research work, such as teaching, pastoral and academic citizenship work, including inclusion & diversity work.
    - There is inadequate funding provision for long-term leave.
    - There is inadequate consideration in funding structures for part-time and flexible working options.

ii. *Balancing diverse commitments*
    - Key issues include that long working hours are seen as necessary for career progression; a lack of part-time and flexible working options makes it harder to manage caring responsibilities; and the provision of affordable, high-quality childcare is frequently inadequate.

iii. *An out-dated culture in academia*
    - We found that decisions about recruitment and promotion lack transparency and fairness; quality of management and leadership in UK chemistry departments is inconsistent, with few relatable role models; and there is a tendency for academic citizenship responsibilities to fall to women.

5.4 Higher education inequalities

i. To better understand the observed attrition of Black students after undergraduate studies, we analysed HESA 2019/20 student data to look into the institution type where they study as we know that funding and research opportunities are not equal between the research-intensive Russell Group universities and post-92 and other non-Russell Group universities.[6]

[6] This data analysis will be published in our upcoming report focusing on race and ethnicity

ii. At the undergraduate level, Black students are roughly equally divided between the 3 institution types, with 36% at post-92 universities, 26% at other non-Russell Group universities and 38%, the slightly largest proportion, at Russell Group universities. Compared to their peers, there is a lower proportion of Black students enrolled at Russell Group universities; 58% of White students, 49% of Asian students, and 56% of students from all ethnicities are at Russell Group universities. We also know from this same data that the representation of Black undergraduate students against the chemistry student population is lowest at Russell Group universities. At the PhD level, similarly, although the majority of Black students are pursuing their degrees at Russell Group universities, they are again underrepresented in this environment.

iii. The underrepresentation of Black students at Russell Group universities may therefore be a contributing factor in the overall underrepresentation of Black chemists after university, as those at post-92 and non-Russell Group universities may face additional barriers to progression due to lack of funding and research opportunities, and/or lack of recognition of individual achievements and potential. Meanwhile those Black students who are at Russell Group universities may face additional barriers connected with their underrepresentation (*see 5.5*).

5.5 Sense of (not) belonging

Our 2021 report *A sense of belonging in the chemical sciences* [10] found that, although non-belonging can impact everyone, chemists from underrepresented groups are less likely to feel they belong in their place of work and/or study. The evidence demonstrated the significant impact of a sense of not belonging on retention, and therefore that this correlates with particular groups being underrepresented. The report identified four key factors impeding belonging:

i. Being told that you don't belong, directly or indirectly (*see also 5.6-5.7*). Several chemists shared stories of being told by family, friends, colleagues or managers, that they wouldn't be able to do a chemistry degree, get funding for a PhD or become a lecturer, or that chemistry really wasn't for them. Sometimes chemists inferred they didn't belong from indirect comments or behaviour; for example, being passed over for professional opportunities, a feeling of not being taken seriously as a professional contributions being ignored or not acknowledged.

ii. Being the only one with a particular lived experience or identity. Chemists described how the absence of other people "like me" impacted their sense of belonging in the chemical sciences. For example, being the only person from a minoritised race or ethnicity in the team, the only out LGBT+ person or the only person with a mental health problem willing to share it.

iii. Being excluded and 'othered' by peoples' assumptions, stereotypes and biases (*see 5.7*).

iv. How chemical scientists experience the culture of chemistry, arising from its demographics and shared values, norms, behaviours, skills and experiences. This includes:

    - The lack of diversity in the chemistry community, particularly at senior levels, which has shaped its culture in ways that mean it can be harder for women and chemists from minoritised ethnic groups to feel like they belong. The

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inequalities in the chemical sciences, the findings of which were partially presented at our 2021 Inclusion and Diversity Forum. Similar findings from our analysis of 2017/18 HESA data are publicly available [9].

presence and behaviour of cliques with their own strong sense of belonging, demonstrated for example through nicknames and in-jokes, can reinforce other people's sense of not fitting in.

- In academic chemistry, a tendency towards a critical, competitive culture, and the under-valuing of interpersonal and 'softer' skills, may reinforce the sense of not-belonging for those chemists valuing a more collaborative, supportive environment *(see 7.1.iii)*.
- An elitism about 'pure' chemistry, which means people with a different or interdisciplinary science background, as well as those from less privileged socioeconomic backgrounds, can find it a struggle to feel like they truly belong.

5.6 Bullying and harassment

i. In *Breaking the barriers* [6], we uncovered evidence of discrimination, bullying and harassment and a systemic failure to deal with these issues effectively. Some respondents even described harassment and bullying as characteristic of academic departments. A number of respondents referred to the 'unchecked power' of managers in some teams and institutions. There is clear concern about a culture of secrecy and lack of accountability around harassment.

ii. We also know that discrimination and harassment are disproportionally experienced by the LGBT+ community in the physical sciences, with 19% of respondents working in chemistry having experienced exclusionary, intimidating, offensive or harassing behaviour because of their gender identity or sexual identity in the last 12 months. This has a clear impact on the underrepresentation of LGBT+ people: 28% of LGBT+ respondents stated that they had at some point considered leaving their workplace because of the climate or discrimination towards LGBT+ people, and nearly half of trans respondents had considered leaving their workplace for this reason [7].

iii. Discriminatory and exclusionary behaviour was also evident in our research into race and ethnicity inequalities. Chemists from Black and other minoritised ethnicities reported experiences of overt exclusion. One participant was told as an undergraduate: "this place is not for your sort". However, most exclusion is subtle and therefore difficult to challenge. For example, many participants described a pervasive "Black tax" – being subject to greater scrutiny, being more closely monitored and held to a higher standard than White colleagues. Participants said that this kind of regular discrimination does more long-term damage than major confrontations around race. For some this directly impacted on their motivation and commitment to stay the course.[7]

5.7 Implicit bias and exclusionary environments

i. One of the four key factors identified in *A sense of belonging* [10] was that other people's assumptions, stereotypes and biases - conscious and unconscious - get in the way of chemists' sense of belonging. Chemists described facing prejudice in various forms, including microaggressions, often based on protected characteristics; several described the effect of this as 'othering'. Moreover, some said their sense of

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[7] This data analysis will be published in our upcoming report focusing on race and ethnicity inequalities in the chemical sciences, the findings of which were partially presented at our 2021 Inclusion and Diversity Forum. Similar findings from our analysis of 2017/18 HESA data are publicly available [9].

not-belonging could be exacerbated when colleagues are unwilling to discuss or take action against exclusionary behaviour.

ii. In our 2020 report *Is publishing in the chemical sciences gender biased?* [4], an analysis of the gender profiles of authors of more than 700,000 manuscript submissions to RSC journals during the period 2014-2018 found that 35.9% of authors were women. As the report shows, this percentage tallies with other measures that we used to assess the overall gender balance of the chemistry community. Furthermore, we identified biases at each step of the publishing profiles, recognising that both the publication of research articles and the number of citations that those articles gather remain established markers of scientific success, putting women at a significant disadvantage in terms of promotion and retention.

   - Only 29.2% of corresponding authors are women, suggesting a link in the lack of visibility associated with being a corresponding author with the lack of retention of women in academia.
   - Only 24.5% of reviewers are women, and this is principally due to women being invited to review less than men are invited.
   - Women are much less likely to be the sole author of a paper (19.6% of sole-authored submissions are from female authors).
   - Women are less likely to submit to journals with higher impact factors.
   - Papers by female corresponding authors are cited less than those from male corresponding authors (5.6 times vs 7.2 times). Men cite female corresponding authors less than male corresponding authors (only 17.8% of citations from male corresponding authors are to female corresponding authors).

   While these results focus on gender bias and on publishing as one activity in the research process, evidence suggests that conclusions drawn might be extrapolated across the sector and across the experience of other minoritised groups, especially in areas that require a form of assessment or evaluation.

5.7 Barriers to progression from compulsory education to further study and training in the sciences

i. 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. Students' 'science capital', defined in the 'ASPIRES 2' research as '*all the science-related interests, attitudes, resources, behaviours and social contacts that a person might have*', as well as other factors including dominant educational and social representations of science associating it with 'masculinity' and 'cleverness', have an impact on whether young people see science as future career or study option [45].

ii. Inequalities also exist in young people's access to certain science qualifications. Multiple routes to study the sciences at GCSE mean that students must make decisions at the age of 14 that could narrow down future options for work and study. Many students' choices are constrained by educational 'gatekeeping' practices [45]. Schools will decide which qualifications are offered, and to which students. Our research has identified examples of factors used to allocate students to GCSE combined or triple science e.g. a science assessment or exam (46%), the set a student is in for science (42%), student decision (37%) [15, page 25]. This creates the 'illusion of choice'; although multiple routes exist, not all routes are open to all students which leads to inequitable access.

iii. Inequitable access also arises because students studying triple science are more likely to come from socially advantaged backgrounds. Research by the Sutton Trust found that 20% of higher attaining students eligible for pupil premium attended schools that do not offer triple science compared with only 12% for higher attaining students from more advantaged backgrounds. Perception of qualification 'difficulty' may also limit student confidence and expectation of what can be achieved, and consequently their options for progression [37].

iv. Schools differ in how they deploy their science teachers. Our research [15] found that there is a widespread practice of teachers of the sciences being deployed outside of their 'specialist' discipline. Long-standing relative differences in teacher shortages between the three school science disciplines (the shortage of expert physics teachers is more pronounced than that of chemistry teachers, and schools usually find it quite easy to recruit biologists), inevitably affects deployment decisions. Again, inequalities are evident in the system, 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 [40, see also 41]. This is a problem as evidence suggests that the most effective teachers have good subject and pedagogical content knowledge. Moreover, passionate expert teachers of chemistry can influence students' decisions to continue their studies in the subject and pursue a STEM related career.

6 The implications of these groups being underrepresented in STEM roles in academia and industry

i. There is substantial evidence that diversity in STEM is vital for high quality research and innovation and to enable scientists to address the world's economic and societal challenges. It is a core believe of the RSC that for the chemical sciences to prosper, they must attract, develop and retain a diverse range of talented people.

6.1 Impacts on science outcomes and performance

i. Our 2021 report *A sense of belonging in the chemical sciences* [10] found that, although belonging and not-belonging can impact everyone, chemists from underrepresented groups are less likely to feel they belong, and this has a negative impact on their retention, progression and scientific outputs, as well as on themselves as people. Within the terms of reference of this submission, 'belonging' in the below points should thus be considered to correlate with diverse and inclusive work environments, while 'not belonging' for those from underrepresented groups correlates with the underrepresentation of those groups and its causal factors.

ii. A sense of belonging leads to better science outcomes. Chemists are more innovative and creative when they feel like they belong. They worry less about being judged and feel freer to share their opinions and give things ago. They are more passionate about their work, more collaborative and more focused. Employees who feel a strong sense of belonging have 56% higher performance than employees who do not feel they belong as stated in our report.

iii. Conversely, not belonging negatively impacts science outcomes. Chemists who don't feel they belong are less likely to contribute their ideas, are more hesitant or qualify what they say.

iv. Belonging improves mental health and well-being. When chemists feel they belong at work they feel happier and more confident, energetic, motivated and empowered.

v. Not belonging impacts performance, progression and retention. Feeling of not belonging is associated with a sense of under-performance, of losing motivation, falling 'out of love' with chemistry, and seeing careers stall. Over time, not-belonging leads chemical scientists to ask whether chemistry is the right place for them.

6.2 Impacts on economic recovery, strength of the sector, and addressing global challenges

i. In our 2020 workforce report, *Chemistry's contribution: Workforce trends and economic impact* [3], we provide a five-point action plan aimed at strengthening the chemical sciences workforce to enable economic recovery. The report identifies strong links between skills and innovation and outlines the vital role the chemistry workforce will play in boosting the UK economy and recovery. Diversity in the chemical sciences is vital to that innovation.

ii. Respondents from *Breaking the barriers* [6] reported the following implications of a lack of gender equality in academia:

  - "The widest pool of scientists results in the best science. Excluding or diminishing any section of society weakens science."
  - "We are losing excellent scientists... not only is this desperately unfair but will have ramifications on research both past, present and future."
  - "Current and future students will come from diverse backgrounds. The idea that universities will be able to compete in the future with an almost entirely English, white male professoriate is laughable."
  - "UK plc is missing out by not making the most of its talent pool."
  - "We lose so many amazing minds to other sectors because of the employment terms in academia."
  - Similar evidence has been revealed by the findings of our upcoming report on race and ethnicity inequalities in the chemical sciences, particularly as relating to the under-representation of the Global South in STEM and the chemical sciences. This is particularly the case in relation to the United Nations Sustainable Development Goals, in which chemistry plays a critical role and will require global solutions to approach global challenges, with the proactive and sustained commitments and cooperation between the Global North and South.

7 What has been done to address underrepresentation of particular groups in STEM roles

i. There are many organisations leading or participating in activities that address the under-representation of particular groups in STEM. For the purposes of this inquiry response, we are focusing on work that the RSC is directly leading or participating in regarding under-representation in the chemical sciences.

7.1 Interventions and activities not specific to any under-represented groups

i. Bullying and harassment. Following *Breaking the barriers* [6] and the evident prevalence of bullying and harassment, we launched the chemical sciences' first bullying and harassment support service [16], supported by the Chemists'

Community Fund. The service has been used every month since launch by individuals within the UK and internationally, providing support related to bullying, racial harassment, victimisation, sexual harassment or career-related bullying. Additionally, we are members of the UKRI forum to tackle bullying and harassment.

ii. *Cultures of belonging.* Following our 2020 report *A sense of belonging in the chemical sciences* [10] we are currently developing a toolkit for institutions, companies and organisations to support them in fostering a culture of belonging in the scientific workplace.

iii. *Review of recognition.* Following our 2019 *Review of recognition* report [17] that presented the results of a review of our recognition programme, we committed to evolve scientific recognition. This has included actions in 2021 and 2022 to diversify the type of contributions that we recognise, for example:

- Greater recognition of teaching activities – one of the activities for which a lack of recognition was found to disproportionately affect women in our Breaking the Barriers report.
- Balancing our portfolio across career stages, recognising that there is currently more opportunity to recognise diverse people at earlier career stages.
- Increasing recognition of teams and collaborations, which goes hand-in-hand with recognising different types of people (career stages, employer type and job roles).
- Setting conduct expectations and revoke prizes where those expectations are not met, with expectations set out in our Code of Conduct, including the expectation to 'never act in a way that could be interpreted as being discriminatory'.

Preliminary data demonstrates significant changes in recognition and reward as a result of this review, with increases in the numbers of early-career scientists including students, people working in industry, and people in professional and technical roles. We anticipate that this reflects a greater representation for people from underrepresented groups in STEM; data from 2021 specifically demonstrates a significant increase in the proportion of women nominated for and receiving recognition [18].

iv. *Funding.* In 2019 we launched the RSC Grants for Carers [19], supported by the Chemists' Community Fund, for those with caring responsibilities to apply for up to £1,000 per year to cover the cost of care they usually provide while they attend a chemistry-related meeting, conference or workshop or a professional development event. Though created in response to a community need identified by *Breaking the barriers* [6], the Grants for Carers are not exclusive to women.

v. The RSC also provides financial support for others in the chemical sciences community who are addressing the under-representation of particular groups, including:

- The RSC Inclusion & Diversity Fund [20] provides financial support up to £5,000 for community-led projects aimed at increasing inclusion and diversity in the chemical sciences. In addition to the regular application rounds twice per year, we have issued two special calls with ringfenced funding to support projects targeting specific under-represented groups, as outlined in the next section 8.2. Since its inception in 2016 the RSC Inclusion & Diversity Fund has awarded grants to 140 community-led projects in a variety of formats and including projects related to gender, disability, socio-economic background, language, race and ethnicity, the LGBT+ community and more.

- Following *Chemistry for All* [8], we launched the RSC Chemistry for All Outreach Grants [21] awarding 8 grants of up to £25,000 to support universities, consortia of organisations or charities to interpret the findings from Chemistry for All and apply these in the design and implementation of a two-year outreach programme for school students.
- The RSC Outreach Fund [22] provides financial support for projects that support the development and delivery of chemistry engagement opportunities for public and school audiences. In addition, since 2021 a proportion of the annual budget has been ring-fenced to support highly targeted initiatives for under-represented audiences and communities. Since inception in 2014, over 450 grants have been awarded to support a range of projects, including initiatives for young people experiencing social deprivation, science clubs for young patients with mental health conditions, activities for young carers and initiatives for girls from families affected by domestic violence and substance abuse.

7.2 Interventions and activities targeting specific under-represented groups

i. *Women and gender bias in publishing.* Following our 2020 report *Is publishing in the chemical sciences gender biased?* [4], we lead the development of a *Framework for action in scientific publishing* [5] and established the *Joint Commitment for Action on Inclusion and Diversity in Publishing* [11] with 47 other publishing organisations. The signatories of this joint commitment have released six minimum standards [12] to help cultivate an inclusive environment for all. This Joint Commitment could have a very significant impact on fostering a more inclusive and diverse research community globally, in STEM and beyond.

ii. *People from minoritised ethnic backgrounds*. Preceding our upcoming report on race and ethnicity inequalities in the chemical sciences, and following our analysis of HESA ethnicity data for UK academic chemistry [9], we have so far responded with the following interventions to help address the under-representation of Black and minoritised ethnicity people in the chemical sciences:

    - Conducted an open consultation with the chemical sciences community on racism, discrimination and ethnic inequality in July 2020.
    - Issued an Inclusion and Diversity Fund Special Call for community-driven projects that support the inclusion and retention of Black people in the chemical sciences, which supported 15 projects globally including 11 in the UK.
    - Held an Inclusion and Diversity Forum in 2020 and 2021 focused on race and ethnicity, which together attracted over 800 registrants from around the world.
    - Launched the pilot Destination STEMM – Chemical Sciences mentorship programme for year 12 chemistry students who are Black, Asian or Minority Ethnic, in partnership with the Windsor Fellowship and supported by the RSC Chemists' Community Fund. The programme supports the students as they navigate the transition from school to chemistry-focused degrees and pathways [26].

- Convened senior leaders in industry to create a collaborative pilot programme to address the under-representation of Black people and those from other minoritised ethnicities in the chemical sciences through career options in industry and innovation.
- Brought together international funders and publishers to tackle the lack of racial and ethnic diversity in the chemical sciences, define goals and measure progress.

iii. *Disabled people.* In 2019, we launched the RSC Accessibility Grants (previously 'Assistance Grants') [23], supported by the Chemists' Community Fund, for disabled chemists to apply for up to £1,000 per year to help with the cost of specific support (any form of equipment, service, or other personal expense associated with meeting their access needs) to attend a chemistry-related meeting, conference, workshop or professional development event. In 2021 we also issued an Inclusion and Diversity Fund Special Call for community-driven projects that improve accessibility and inclusion for disabled people in the chemical sciences, which supported 9 projects globally.

iv. *LGBT+ people.* Following our 2019 report [7], in 2020 we created the RSC LGBT+ Toolkit [24], a set of audience- and topic-specific resources that tackle the key issues faced by LGBT+ physical scientists, which provides the tools for everyone to take part in positive change: employers, colleagues, and LGBT+ individuals. The toolkit has received uptake and positive feedback worldwide and, though created to specifically address LGBT+ under-representation, it provides guidelines for belonging and inclusion that many who are under-represented will benefit from if implemented. These include strategies for individuals to act in active allyship with those from underrepresented groups, as well as detailed advice for employers on instituting robust reporting and feedback frameworks so that exclusionary behaviour can be addressed.

8. What could and should be done by the UK Government, UK Research and Innovation, other funding bodies, industry and academia to address the issues identified

8.1 Section summary

In summary, the UK Government, UKRI, other funding bodies, industry and academia needs to:

i. **Address gaps in evidence, monitoring and reporting** – we need greater transparency in reporting equalities data to enable the sector to learn lessons and share best practice.

ii. **Address inequalities 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 has developed a number of suggested actions for funding bodies, with broader applicability in some cases; a key example is the need to review and expand definitions and measures of success and excellence in STEM.

iii. **There needs to be greater flexibility and adjustments** – flexibility and adjustments 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 as part of ensuring that necessary support is in place and fit for purpose. Those with chronic energy-limiting conditions need greater support and consideration, and this area will only become more relevant in light of 'long Covid'.

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 in this area and has 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. **Inequalities in education** – 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. **Shifting 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.

In the remainder of this section, we provide further details and justification for each of these points, as well as more specific recommended actions for different bodies.

8.2 Gaps in evidence, monitoring and reporting

i. Access to high-quality data and evidence is essential to improving the diversity of the STEM workforce. To ensure talented people thrive and progress in the chemical sciences, we need greater transparency in reporting the data that gives us insight into the barriers people face and the ways in which we can remove them.

ii. Systematic data are limited outside of statutory reporting requirements, limiting available evidence particularly in industry. Obtaining self-reported data across the sector remains a challenge. In the RSC *Diversity data report 2020* [1], response rates of self-reported diversity data ranged between 9.0-73.8% across the different areas. We identified the critical need to develop trust within the community to encourage higher rates of self-reporting, and to communicate the importance of self-reporting in order to obtain robust data to guide our work in making chemistry more accessible and inclusive for all.

iii. Funding bodies and institutions have a key role to play in fostering this environment of trust and should also consider how they might increase transparency such as through the systematic provision of diversity data in reference to funding awarding. Funding bodies, institutions, organisations and companies should also share evidence of improvements achieved, so that models of best practice can be utilised by the community.

iv. At the level of government, actions to encourage greater collection and transparency of data should include considering requiring ethnicity pay gap reporting, along similar lines to gender pay gap reporting.

v. There is additionally a need for intersectional data, in order to understand the challenges faced by those belonging to multiple underrepresented groups and how these may differ in nature and/or extent *(see 3.3, 4.7)*.

8.3 Funding, reward and recognition

Our evidence points to continued inequalities in salary and reward across academia and industry *(6.2)*, and in research and innovation, to the significant impact of funding systems as a structural barrier to equality in chemistry for multiple underrepresented groups *(see 5.1.iv, 5.3)*.

i. Our 2018 report Breaking the Barriers suggested a number of actions funding bodies should take to address the underrepresentation of women in academic chemistry. We further believe that these actions would impact positively on the representation of other groups; our preliminary research indicates that points 3 and 5 are particularly important for disabled people in the chemical sciences.

    1. Review career pathways. Explore options for new models / roles (including senior roles with a teaching focus).
    2. Provide more longer-term contracts for early career researchers.
    3. Make flexible and part-time working possible, at scale.
    4. Make funding contingent on progress on diversity.
    5. Improve funding for care (including parental) and sickness leave and returners.
    6. Review current definitions of 'excellence' in science research (including the setting of conduct-based expectations – *see 8.4*).
    7. Value evidence of success in non-research roles.
    8. Increase accountability of funded managers *(see 8.4)*.

ii. Alongside reviewing current definitions of 'excellence' (action 6 above), it is important to be transparent about the definition of terminology and criteria used. A 2020 report by Science Europe [44] indicated that of the funding organisations that reported using the term 'excellence' in their assessment criteria, none provided a formal, single, definition of the term. Furthermore, although determining quality is a central premise of assessments, most responding organisations did not have a formal definition of quality either.

iii. The Government's R&D People and Culture Strategy [33, 34]recognised the importance of a diverse R&D workforce and committed in the short term to creating a Good Practice Exchange to develop, test, evaluate and highlight ideas to improve research culture, particularly inclusion & diversity interventions. We welcome this as a positive contribution to the project of rethinking recognition, broadening narrow definitions of excellence, reversing the 'publish or perish' trend in research which disadvantages underrepresented groups, and ensuring that non-research work is recognised and rewarded. It is imperative however that inclusion and diversity be specifically considered as a constitutive pillar of initiatives such as the proposed Résumé for Research and Innovation [35] and that addressing structural inequalities continues to remain squarely in focus and prioritised in such initiatives. It is moreover important that the impacts of such initiatives are measured and reported on so that their impact on underrepresentation can be evaluated and other funders can learn and adopt successful initiatives.

iv. We note and welcome that issues of 'diversity' are addressed in the terms of reference for the upcoming Future Research Assessment Programme [36] which will be reviewing the Research Excellence Framework. It is crucial that this programme explicitly considers within its purview the structural barriers in research funding systems we have outlined above, many of which linked to and indeed epitomised by the REF. These barriers contribute significantly to the underrepresentation and lack of adequate recognition and reward of the work of minoritised groups in research and innovation. This is especially important in the light of evidence such as that from the University and College Union's 2013 survey report [39], which shows that significant proportions of staff considered REF selection processes discriminatory according to one or more protected characteristic, particularly disability.

8.4 Flexibility and adjustments

i. As underlined in the above sections, flexibility in work is a key part of enabling equal participation for those from underrepresented groups. This is especially important for disabled people as well as for those with caregiving responsibilities, who are disproportionately likely to be from underrepresented groups, particularly women.

ii. The availability of flexibility in working patterns will contribute to addressing underrepresentation for many; this includes the increased availability of options for flexible hours, part-time working, job-sharing, and working from home in part or in full, as well as the availability of paid leave, including longer-term leave for parental or caring responsibilities and/or for illness and recovery. The pandemic demonstrated the degree to which such options are often possible in places where they were not previously anticipated or considered, and the increased prevalence of these options should continue into the future. As noted in 9.3 the need for increased flexibility is something funding bodies must take into account and should also be a key consideration for industry. The expectation in the chemical sciences to work long hours has also been cited as a barrier for multiple underrepresented groups, and initiatives to curb this must come from setting institutional expectations around healthy workloads as well as from rethinking measures of success and excellence *(see 8.3)*.

iii. It is imperative that existing systems of support, such as Access to Work and Disabled Students' Allowances, are fit for purpose to combat the underrepresentation of disabled people in STEM. In addition to widespread and significant delays in provision and other general barriers, a particular problem arises where assessors for these schemes lack expertise in scientific and technological areas, resulting in a lack of knowledge and understanding as to what kinds of support, adjustments, equipment, technology etc are possible and necessary. For example, in our preliminary research we have heard that disabled chemists face barriers accessing support from Access to Work and DSAs due to lack of technical understanding in reference to the tasks and tools required for laboratory-based chemistry research.

iv. The impact of the pandemic also raises concerns in relation to 'long COVID' and points to the importance of considering those with chronic energy-limiting conditions. At present, this subset of disabled people is generally misunderstood and overlooked.

   - It is firstly imperative that those with chronical energy-limiting conditions be considered at the governmental level, perhaps by offering benefits support for those who are medically able to work only a limited number of hours, rather than requiring either employment or evidence of complete medical inability to work. An additional imperative is to review the ways in which limitations of the current system of disability and welfare benefits in the UK may contribute to the underrepresentation of disabled people, and those from other marginalised groups, in STEM.

- Funding bodies must also consider those with chronic energy-limiting conditions; at present, for example, there is no high-level funding provision for postgraduate study on a part-time basis due to disability. Funding for sick leave from studies assumes a simple binary between ‘sick’ and ‘healthy’ which is inapplicable to those with chronic energy-limiting conditions, a demographic which promises to increase in number in the wake of the pandemic.

8.5 Increasing accountability; eliminating bias, bullying and harassment; and building cultures of belonging.

i. At a governmental level, there is presently limited recourse to legal routes to accountability due to the requirements for bringing a case under the Equality Act 2010 and the lack of availability of legal aid for the majority [38]. Better accountability is a consistent finding through all our reports and must be a priority for institutions, and a legal backstop that is financially accessible to the majority is a crucial part of better inclusion and diversity in STEM.

ii. Further than drawing attention to ‘unconscious bias’ on an individual psychological level, steps must be taken to concretely mitigate its effects on a structural level. Decision-makers at all levels should be provided with training enabling them not only to notice their own implicit bias, but also to actively impede their and others’ bias from impacting upon decision-making. Organisations, particularly funders, publishers and employers, should collect and report data on biases in all aspects of the research process, particularly with respect to grant allocation, publishing, hiring, promotion and career progression, and responsibly act to mitigate biases where they are observed [25].

iii. Recommendations for funding bodies, academic institutions, and industry employers drawn from our reports:

    - Part of rethinking recognition and broadening definitions of success and excellence *(see 8.3)* is building accountability into systems of reward and recognition. Organisations should enforce a zero-tolerance approach to bullying and harassment; funders for example should enforce by denying funding or building in clauses to ensure that institutions and individuals have funding removed when bullying and harassment is demonstrated [25].
    - Organisations should review organisational policies to ensure inclusivity for underrepresented groups. This should include reviewing recruitment and promotion processes to ensure they are transparent and inclusive, for example considering language in job descriptions and the training that is given to those involved in recruitment and promotion decisions. A review of organisational policy should also cover instituting or reviewing, and subsequently publicising, robust reporting systems for bullying, harassment and exclusionary behaviour; these should generally include means of reporting anonymously.
    - Organisations should be more explicit about their conduct expectations, provide guidelines on best-practice and give more weight to exemplary behaviour. This could include developing expected behaviour and professional practice guidelines; defining good management practice and

making managers accountable for implementation; and giving more weight to exemplary behaviour and non-research activities that promote diversity in hiring and promotions.

  - Organisations should ensure professional events are accessible to all, e.g., consider accessibility for disabled attendees; childcare provision; cost mitigation. They should also consider belonging alongside inclusion and diversity; create and fund opportunities for connection which will improve sense of belonging among underrepresented people [10].
  - Organisations should support and promote effective mentoring programmes and build inclusion and diversity considerations into these.

iv. Recommendations for publishers drawn from our reports:

  - Increase transparency and openness around publishing processes.
  - Provide guidance to train scientists on how to objectively critique papers, provide constructive criticism and identify and mitigate implicit bias.
  - Provide tools for editors and reviewers to aid the provision of more constructive feedback to authors.
  - Improve diversity within editorial boards, during commissioning and when choosing reviewers.
  - Sign up to the Joint Commitment for action on inclusion & diversity in publishing [11].

8.6 Addressing inequalities in education

i. Every year, around 25,000 students achieve applied science qualifications. The removal of their funding risks closing off this option for thousands of students, at a time when increased participation in science is important to ensure the ongoing development of skills for initiatives such as the Industrial Strategy, increased spend on R&D and Net Zero goals. Alternatives to applied science qualifications (A Levels and T Levels), may not be accessible or attractive to students who would have previously taken applied science qualifications.

   According to the impact assessment [32] this could have impacts for diversity, as students with certain characteristics are over-represented on the qualifications that are expected to be no longer offered. This includes students with special educational needs, students from Asian and Black ethnic backgrounds, and those from the most disadvantaged backgrounds.

ii. One of the key findings from our research into level 4 and 5 Higher Technical qualifications in subject areas related to the chemical sciences was that these qualifications support a wide range of learner journeys and attract a diverse range of learners [27]. Qualifications at this level may for example be more attractive than undergraduate degrees to recent migrants, those from poorer families, and those who have struggled in their educational histories. Future proposals for higher technical qualifications are welcome in their intention to raise the profile of technical education and give recognition to the importance of technical skills in areas such as chemistry. However, care must be taken that the reforms do not inadvertently erect barriers; for example, the establishment of distinct academic and technical pathways must not result in loss of flexibility in progression options.

iii. Our *Chemistry for All* research and report shows that chemistry is not, in fact, accessible to all [8]. To address the inequalities that exist in access to a high-quality school science education and opportunities to progress to further study or chemistry related careers, the government should:

   - Reassess long-standing barriers in education such as grading severity, inequality embedded by dual routes of study, inaccessibility and confidence.
   - Support young people's understanding of the value of chemistry to society and to their future careers. Embed this in the curriculum as an expected learning outcome, and support teachers with resources and ongoing professional development opportunities.
   - Provide fit-for-purpose careers advice.
   - Fund effective practical work and STEM outreach activities adequately.
   - Ensure that every child has an unbroken chain of experts teaching them the sciences throughout their school education by: investing in high-quality subject-specific training and development for teachers; addressing teacher recruitment and retention issues; and collecting and recording information about teachers' discipline-specific expertise within the sciences.

8.7 Shifting the burden

A necessity underlining the recommendations in this submission is that a disproportionate burden must not fall on those from underrepresented groups to themselves be obligated to undertake the work needed to address their own underrepresentation.

i. A key issue contributing to a lack of retention and progression of women is that women are more heavily involved with non-research work that benefits the chemical sciences than men, but that this work is undervalued, with funding and promotion decisions driven primarily by research output. For example, respondents reported that efforts and successes in areas including teaching, pastoral responsibilities and academic citizenship activities, including Athena SWAN and REF (Research Excellence Framework) preparation, do not 'count' towards promotion prospects; yet those from underrepresented groups feel disproportionately compelled to undertake this work, currently at the expense of their own research and progression. Multiple interviewees in *Exploring the workplace for LGBT+ physical scientists* [7] cited the burden of expectation that they would take on inclusion & diversity work, particularly in reference to gender. It is therefore imperative that inclusion & diversity work be considered equally with other scientific work and rewarded as such (*see 8.3*), and that emphasis be placed on allyship and the importance of contributing to inclusion & diversity work for everyone.

ii. The evidence in our upcoming report on race and ethnicity inequalities in the chemical sciences also emphasises the impact of representation fatigue, demonstrating again that those who are under-represented are often the ones leading a push for change or being called upon to provide a different perspective, with little support or recognition for their work. As well as impacting on time and energy for research or other structurally more valued work, this impacts on wellbeing. Initiatives that place disproportionate burdens on those from groups they purport to be working to include in addition can have an exclusionary effect. The overreliance on Black chemists and those from other minoritised ethnicities to champion inclusion and diversity highlights the need for allyship and for White colleagues to take on the work of combatting racism.

iii. Moreover, although anybody can be a valuable ally, senior colleagues in particular can often have a significant impact in nurturing a more supportive culture, and expectations around this should be embedded in promotion, evaluation and recognition criteria. Organisations, particularly employers and funders, should support senior and established staff to allocate part of their time to champion equality, diversity and inclusion across all their activities, enable new ways of working and create more inclusive and accessible research environments [25].

Endnotes

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