EPSRC review of doctoral education

Report of the focus groups

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Preface

This report presents the findings from focus groups conducted with current and previously EPSRC-funded doctoral researchers as part of a review of doctoral education currently being conducted by the Engineering and Physical Sciences Research Council (EPSRC). It describes the design, delivery and findings of the focus groups undertaken by Vitae on behalf of RAND Europe.

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Contents

Executive summary

As part of the EPSRC review of their investment in doctoral education a series of focus groups were held with 51 current and 9 previous EPSRC-funded doctoral researchers. These focus groups explored their expectations and experiences of their doctoral education, how well this prepared them for their careers in terms of the knowledge and skills development, and their views of how their doctoral education could be improved.

Current doctoral students have had more than a year of their doctoral education affected by the ongoing Covid restrictions, which inevitably coloured focus group participants' views particularly for first year doctoral students. Nevertheless, participants were willing to talk about a wide range of topics relating to their doctoral studies and several themes emerged that are worthy of further consideration within the review of EPSRC's doctoral education. Covid related findings gathered from the focus groups are presented separately in Appendix 3 as they are out of scope for the EPSRC review. Instead, they will be fed into UKRI's wider monitoring of the impacts of the pandemic.

Reasons for undertaking a doctorate
Participants had a range of reasons for undertaking a doctoral degree with the majority expressing a passion for research and creating new knowledge as the main drivers. Some had long-standing aspirations to become academics, others saw it as a progression through education that should improve their wider career opportunities, while a few acknowledged that a lack of job opportunities due to Covid had influenced their decision. Those who had returned to education (predominately from industry) saw a doctorate as a way to improve their subsequent career progression in industry or to seek an academic career.

Expectations of the doctoral experience
Participants saw their doctoral education as an opportunity to focus on research and explore a topic in more depth, anticipating the critical thinking and problem-solving this would require. They expected to have both the experience of working independently, managing their own project and path; and working with their supervisor and having access to the wider academic community. Some were specifically interested in collaborating with industry and interdisciplinarity.

They anticipated challenges in managing their workload and achieving a work-life balance. There were also concerns about whether, working independently, they would be able to stay motivated and focussed. Imposter syndrome was also highlighted as a concern and whether they would be able to achieve the expected depth of research and hold their own within the academic community.

Experience of their doctoral provision
Inevitably the impact of Covid on their experience threaded through discussion. These are captured in Appendix 3.

More effective inductions and targeted signposting of institutional support services were seen as ways to help doctoral students navigate institutional systems. Participants described doctoral students as falling into a grey area between student and staff. A few reported struggling to understand which institutional services they could use and how to access these, with student support and mental health services specifically mentioned.

Training and development provision was seen as comprehensive and useful, with participants describing provision at the CDT (Centre for Doctoral Training), institution-wide and cross-institution. There were mixed views about the value of the 1+3 model, with some participants preferring a flexible, personalised programme of training across the doctoral degree, rather than a compulsory programme of training in the first year. There were a few examples of supervisors not valuing time spent on professional development activities.

Participants described the skills and attributes they expected to develop during their doctoral education and would be useful for their career using the Researcher Development Framework (RDF)[1]. These included: intellectual abilities, such as problem solving and critical thinking; personal effectiveness, such as self-organisation and perseverance; research practices and processes; and making an impact through communication skills, team-working, networking. They recognised the usefulness of their doctoral skills across a wide range of employment opportunities.

Supervision
Participants were generally very positive about their supervisory experiences, describing their supervisors as "*knowledgeable", "supportive", "flexible", "engaged", "available", "knowing when to intercede and when to step back".* There was some heartfelt gratitude for the support some supervisors had provided during Covid. A few had had less positive experiences of supervision and described their supervisors as *"disengaged", "inflexible" or "directive".* They said they were reluctant to raise any issues due to the power imbalance and (perceived) possible consequences for their research and career prospects. They also noted that different motivations between academic and industry supervisors, or across disciplines, could be challenging to navigate. There were a couple of examples where unavoidable changes in supervisors had resulted in gaps in supervision and disruption.

Value of the doctorate for their careers
Participants generally recognised the value of the doctorate to all career choices, noting that it developed a different skill set from lower degrees. How well prepared they felt for their careers depended on how certain their career intentions were. Those aspiring to an academic career were most likely to say they felt well prepared and knew what to expect. However, there were some strong views on the attractiveness of an academic career, even from those participants who definitely wanted to be an academic, with perceptions of job insecurity, lack of career paths, low pay, poor working environment and a highly competitive culture discouraging participants from embarking on a career in academia. Those considering a career in industry valued the opportunity to have extensive interactions with industry and the insights these had provided in terms of what companies are looking for from employees, their working cultures and job opportunities.

Funding and status of doctoral researchers
The status and funding for doctoral students emerged as a key theme with some animated discussions on whether doctoral researchers should be students or employed as staff. They questioned the different lengths and levels of EPSRC stipends, suggesting there needs to be more clarity and consistency within and across funding schemes. There were calls for better associated stipend benefits, including sick pay, holiday entitlements, pension entitlements,

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[1] www.vitae.ac.uk/rdf

maternity/paternity benefits and family allowance, adjustments for disabilities. They stressed the importance of these in facilitating equality of access to doctoral education for disadvantaged groups and those with particular circumstances. However, there was a lack of awareness that some of this support is already provided by UKRI under their terms and conditions for funding.

Influencing institutional provision and practice
When asked how EPSRC could improve their doctoral provision, participants believed that EPSRC could influence changes at the institutional level through stronger policies and requirements within their conditions of funding. There was general scepticism whether institutions or supervisors would change without having external pressures. They were also generally unaware of existing EPSRC policies, for example relating to training requirements.

Building the EPSRC doctoral community
Participants reported having almost no contact with EPSRC, other than their funding. A consistent theme across all the focus groups was interest in having a stronger relationship with EPSRC, for example through EPSRC providing newsletters, events or online platforms to leverage the potential of the wider community and facilitate opportunities for collaborations or promoting job opportunities. They proposed EPSRC develop mechanisms for getting feedback directly from doctoral students through, for example, confidential surveys, exit interviews, and doctoral student representation on the oversight of EPSRC doctoral programmes, including this current review.

1 Introduction

As part of the review of their investment in doctoral education, EPSRC commissioned RAND Europe to undertake a review of the published literature relating to doctoral education in the physical sciences and engineering disciplines, and deliver a series of focus groups with current EPSRC-funded doctoral students and doctoral graduates (alumni) to explore their view of their doctoral education. This report covers the delivery and outcomes from the focus groups.

Vitae, on behalf of RAND Europe, delivered five focus groups with current EPSRC doctoral researchers between 14th June and 1st July 2021. The aims of the focus groups were to gather participants' views on and experience of doctoral education, specifically their:

- initial expectations for their doctoral education
- experiences of their doctoral education
- preparedness for their preferred career path, including their acquisition of knowledge and skills development
- views on how their doctoral education can be improved.

A further focus group was delivered with nine previous EPSRC doctoral researchers on 15th July. These recent alumni were asked about their experiences of their doctoral education, particularly how well it prepared them for their careers, the skills they developed and what changes would they recommend to EPSRC. Throughout the report the responses from this focus group are reported as 'alumni participant'. In all other cases, 'participant' refers to current EPSRC doctoral students.

Participants were selected to reflect the diversity of the EPSRC doctoral population and doctoral programmes. Overall, the diversity of participants and range of views expressed across the different focus groups provides a degree of confidence in the breadth of experiences described by participants. However, it is important to note that it is not possible to judge whether the views expressed in the focus groups were representative of the EPSRC doctoral community as participants self-selected to attend and, therefore, were likely to be more interested in the topic or have strong opinions.

2 Approach

The doctoral students focus groups were delivered online across two hours, while the alumni focus group was 90 minutes recognising that they were less likely to commit to longer. Both types of focus groups were delivered by experienced facilitators using a structured question set agreed with EPSRC (Appendix 1). Participants' responses were recorded and subsequently transcribed. Notes were taken and a running record of key messages was also maintained through the online 'whiteboard Padlett, which participants were also invited to contribute to.

Both doctoral students and alumni participants' permissions were obtained to record the focus group discussions under the condition that their contributions and institutions would be anonymised in the transcripts and reports. Plural pronouns have been used throughout the report to avoid identifying gender and further ensure anonymity.

Doctoral student participants were recruited through EPSRC by identifying a stratified sample of EPSRC's 11,600 doctoral students reflecting the range of EPSRC's doctoral funding schemes, the diversity of funded institutions and research areas. This sample also reflected the demographic profile of the EPSRC population in terms of gender, ethnicity, researchers with disabilities and year of study. Minority populations (gender, black and ethnic minorities, disabilities) were slightly over-sampled at the invitation stage to ensure they were appropriately represented in the final selection of participants.

An invitation to participate in a focus group was sent by EPSRC initially to 600 doctoral students. Respondents were able to identify their preferred availability for a range of dates. Following an unexpectedly low response, a further 1200 students were invited to a focus group. In total 83 doctoral students responded, with a quarter only having limited availability.

Between 12-14 doctoral students were invited to each focus group, assuming that there would be a proportion of students who would not attend. Overall, 51 doctoral students participated across the five focus groups. They broadly reflected the EPSRC doctoral population, although women, doctoral students with disabilities, black and ethnic minorities, first year, ICASE students, and those at smaller institutions were over-represented. Those doctoral students funded through Doctoral Training Partnerships (DTPs) and from institutions with more than 500 EPSRC-funded students were under-represented. The detailed profile of participants compared with the EPSRC population is given in Appendix 2.

EPSRC doctoral graduate alumni were recruited by EPSRC asking Training Grant Holders to forward the invitation to their previous doctoral researchers. This resulted in over 120 responses, of which 12 were invited to the alumni focus group and 9 attended. Alumni participants were selected to provide a range of current occupations and employment sectors, different funding schemes and institutions. Alumni participants had graduated between 2016 and 2020. More information on the profile of alumni participants is given in Appendix 2.

Transcripts and summary of the key themes for each of the focus groups are provided separately to EPSRC. It was also recognised that the relatively large number of responses from alumni presented an opportunity to gather feedback from this community beyond what was possible through the focus group. A survey consisting of a short set of questions was agreed with EPSRC and sent to the alumni who were not offered a place on the focus group. The responses to this survey are also provided separately to EPSRC.

3   Reasons for doing a doctorate

Doctoral student participants typically described three reasons for undertaking their doctorate.

By far the largest category were those who expressed a passion for research that was typically triggered by their final undergraduate year research project or their masters' thesis. A common statement was the desire to reach a deeper understanding of a particular issue or discipline.

> *It's the research. I knew that from the first taste of real research, I was hooked. I enjoy the challenges, the problem solving, just looking into everything.*

What motivated me to do my PhD is I did my undergrad at [Institution] and got involved in research in the area as part of my final year project. And I was very fortunate to be offered an opportunity to do a PhD off the back of that. And what motivated me to express interest in doing one in the first place is I was really interested in the area of research for research motivated reasons.

I originally didn't want to do a PhD, I was actively set against it until my fourth year. I did an integrated masters, so my fourth-year research product was, kind of, on a similar theme to what my PhD has been. And I really loved it, but I took a gap year because I wanted to make sure it was a path I wanted to go on, that I wasn't just defaulting into it. Because I think some of my friends, when they didn't know what to do, applied for PhDs. I was thinking academia and now I'm leaning away from academia.

A small proportion of participants described how they had moved to their doctoral programme as a natural progression from their integrated masters or masters degree. Several noted that the offer of a doctoral stipend had come from their tutor or research project supervisor. An alumni participant noted that research groups could be very homogenous with "*professors bringing in favoured undergraduate students"* and the implication this had for fair competition and diversity

Five participants specifically acknowledged that Covid had limited their job opportunities and 'another qualification seemed a good use of their time', while another was using their doctorate education to upskill following a maternity career break.

I had finished my undergraduate degree and I had worked for a year. And then one of the lecturers there emailed me saying, here's an opportunity to do a PhD. There's some funding come up in this Doctoral Training Centre, would you be interested? I was on a short-term contract, working and thought it's a great opportunity, I'll give it a go.

I think I've always enjoyed learning new things, exploring new things, and considered going into academia in the future and so the PhD seemed like the next natural step in advancing my education.

After my undergrad, I had a work experience of a year, but I realised that my interest didn't really lie in the industry at that point in time, and I was really interested in research. So, I quit my job and I went back and did my masters. In my masters I was exposed to a lot of research and internships abroad which strengthened my perspective towards research. And that helped me decide on doing a PhD.

Around 10% of participants had come from a position in industry to undertake their doctoral degree. Almost all of these participants cited the main reason as their lack (or potential lack) of progress within (their particular) industry without a doctoral degree. After a long-term industrial career, one participant had embarked on a doctoral degree to research into some of the unresolved challenges within their field.

I moved to industry [after masters] for nearly three years. I was a bit bored doing repetitive things, not very challenging. So, I was aiming to change jobs and then Coronavirus happened. I was still going for interviews, but I think they prioritised

people with a PhD. So, I thought it was maybe a good idea to first look for personal challenges and have a better qualification to get the job I wanted in the future.

In my undergrad, I did a year in industry where I spent all day, every day doing research. And that's where I developed an interest to carry on because I found that in industry I was doing the lab work while somebody else was doing the technical and chemistry behind the project. Whereas if I do my own project, then I'm doing both sides which I find far more interesting.

I got my undergraduate in the chemical and pharmaceutical sciences. I undertook a series of placements. And it was at this point that I started to speak to people in senior positions. And basically, I noticed that the people from a career point of view who were in leadership positions seemed to have PhDs, so I was asking them what the reason for this was. They said more to learn and drive your own independent research. So, I decided to have a look around and I found a PhD from a point of view of learning how to drive my own research and potentially become a future leader.

4   Career intentions at start

The majority were undecided about their career intention reflecting the large proportion of participants who were attracted to doctoral studies from an interest in the subject. There was general acceptance that a doctoral degree is not just useful for an academic career, but the knowledge and skills developed can 'open doors' to other careers.

I saw doing a PhD as a really good opportunity to develop a lot of skills, regardless of whether I wanted to be an academic or not. Which even though I'm very happy to say that I'm going on to a post-doc after my PhD, I still don't have my heart set on anything after that.

I'm one of those who hasn't really decided, but I haven't really got much time left on my PhD. But I think I haven't decided because I haven't even had the bandwidth to think about anything else other than doing my thesis and finishing my research. I don't know whether it's because Covid's just made everything a thousand times harder. And if it was a normal year, I would have had that time to think about what I want to do. But at the moment, I'm just so focused that I haven't even thought beyond submission.

I've not decided whether academic or outside of academia. It can be a bit binary anyway. I think you can probably have feet in both camps to some extent. But yes, just keeping my options open at the minute.

A few had strong, in some cases long-standing, aspirations to become academics. More expressed interest in progressing to postdoctoral positions and possibly to academic careers. Even amongst participants who aspired to be academics there were strong views about the attractiveness of an academic career. The independence, ability to explore an area in depth and to innovate were strong driving forces, with a few also expressing a love of teaching.

I decided to do a PhD because I got involved in academic research towards the end of my bachelor's and during my master's and I couldn't imagine doing anything else at this point. So a PhD was just a very sensible next step of that. I love academia. I even

love teaching even though that isn't everyone's favourite part of academia, I guess. So to me this feels like a very natural step.

However, there were animated discussions around the academic environment and culture, particularly in two of the focus groups, with participants highlighting the drive for publications, long working hours, the precarity of the early career phase (with expectations of initial postdoctoral contracts of a year or less), lack of academic positions and poor salaries (compared to industry) as discouraging factors. Several participants recognised that their passion for the research was such that they were prepared to 'suffer' to achieve the autonomy of academic research. Others, having initially been attracted to an academic career, were now doubting their decisions.

We do get exploited, but I still love the research enough that I'm doing my best to stay within research. Because it is the thing that I love doing and I really could do this the rest of my life and be supremely happy. But the pay is obviously low and I'm facing, as a mature student, a lot of obligations…and I don't feel like there's any support.

I'm still in the first year of my PhD and I might change my mind but I still think I'm not that bothered by the difference in salary. Of course, I understand that as years go by, it would seem more lucrative to have a career in industry or to have a higher remuneration. But I think the independence and the freedom we have in research in academia is worth the cost for now, at least. But I agree for PhDs, especially those who might have come into a PhD after a substantial time in industry, this might be an issue.

I've worked in industry for a long time. I've never been employed in academia but I've worked with academics and have some indirect exposure to the academic culture. I do think it's not always the healthiest culture, let's put it that way. I do think academia is obsessed with some of the status questions in a way that I don't find very healthy.

I was involved at my university in supporting the academics strike recently. And talking to them, learning about, essentially, the experience of a person working as an academic in [location] just now, it made it seem not just unrewarding, but exploitative, essentially. And that really put me off working in academia at all, to the point that I'm willing to work in industry, which also has lots of arguments for being exploitative as well.

Around a fifth expressed an interest in working outside academia after their doctorate, with the majority talking about 'working in industry'.

My plan to go and do a PhD was to gain high-level skills and to progress in my career into a more significant responsibility to help to possibly start a new business or start-up company in robotics or machine learning. Or to help UK industries grow in that area because I know there's a lot of potential growth and business opportunity in that area. I'm basically upskilling, trying to gain as much knowledge as I could and support UK growth and business and education in the area.

Those participants who had worked in other employment sectors before their doctorate had more definite career intentions. Either using the doctorate to increase their skills and expertise with the intention of progressing further in industry, or as a deliberate step towards an academic career.

I spent some time working in industry. And basically, every person I spoke to that was working in that kind of field said that essentially to be able to progress in industry, a PhD was essentially just a prerequisite.

I worked in industry for close to a year before deciding to go into academia. It was a conscious decision. I knew the pay would be much lesser than working in industry. But the level of stress and the constraints of research in industry is a huge disadvantage, I would say, when compared to a career in academia.

5 Expectations of the doctoral experience

Doctoral student participants were asked what they expected to enjoy in their doctoral experience and what they anticipated would be the main challenges.

5.1 Enjoyment

The most common responses related to having the time to be able to focus on research: to ask deeper questions and to investigate a topic fully or explore new ideas. This also included continuing to learn and time to read around a particular subject. They were also looking forward to engaging in critical thinking and problem-solving; to come up with innovative solutions.

Participants also highlighted the opportunity to work independently and having flexibility around the choice of project. They were expecting to enjoy being self-directed and organising their own workload and path.

This opportunity of being autonomous and choosing what I think will be important for my research, which I think was a big plus.

Participants looked forward to having access to the academic community and building networks of people with similar interests, of working with their supervisor. Several mentioned the opportunity to do interdisciplinary research and to collaborate with industry, with one participant seeing it as a way of assessing whether to pursue a career in industry. Other benefits mentioned included the opportunity to share knowledge through teaching and supervising undergraduates.

The fact that you will be able to speak with people with the same subject, discuss things. Be able to meet people, travel the world, go to conferences, see different places, and people that they are doing actually the same thing as you.

I think with this whole structure and with the administration that supports the CDT, I've found it a very supportive environment. And I think having a PhD where I was working by myself, the traditional way of doing a PhD. That would have been a deal-breaker for me. I wouldn't have done a PhD if that was the route I had to take. But the support structure has enabled me to go on and do a PhD that I enjoy.

5.2 Anticipated challenges

Participants expected their doctoral experience would be hard work and had concerns about how to manage their workload. One participant noted that not having contracted hours meant that work boundaries were blurred and expected it to be challenging to manage their

work-life balance, *"to be able to have a social life alongside enjoying my work"*. Several mentioned that friends and colleagues had tried to discourage them from embarking on a doctorate.

Generally, the 'newness' of everything was seen as challenging and had been exacerbated by Covid for recent starters, particularly those moving to another university. One international participant felt unsupported in a new university and a new country during Covid.

> *So I did a PhD with my master thesis supervisor, for example, and then you're already familiar with the environment, but I guess starting fresh in a different country at a new university with a new supervisor was something that I thought would be challenging and even more so because of Covid.*

Imposter syndrome explicitly surfaced as a major challenge in two of the focus groups, with one participant expressing their concern as "*with research is so well established, how can one add something meaningful and genuinely new?"*. Other participants recognised that a doctoral degree through research was a new way of working and were concerned about being able to reach the expected depth of research, or their project failing and not having anything at the end. One participant questioned whether they would be able to hold their own within the academic community and write at an appropriate level to be able convey complex ideas to experts. Another participant highlighted the pervasive pressure to publish within academia (but not from their supervisor) was challenging. One participant was pleased to discover that academics are not superhuman.

> *For me the imposter syndrome was one of the biggest challenges. Also, the fact that I was changing the area…that I will be working on. So, I was really scared if I would be able to understand everything. And I was quite scared of that.*

> *What I was pleasantly surprised by is that I thought that to be able to be a scientist you had to have this superhuman amount of intellect. But I noticed that my supervisors are only human. They just know a lot more because they've been working a lot longer in the field. So, then at some point when I go really deep on some specific topic, then I will know everything about it. And I think it's nice to realise that your supervisors are only human, and you can do the same things that they do if you take enough time to get there.*

The opportunity to work independently featured highly in the anticipated benefits of the doctorate, but it also emerged as one of the key expected challenges, Participants acknowledged that the doctorate was more self-driven than previous degrees and expressed concern about whether they would be able to stay motivated when there is so much that can go wrong. They noted the lack of structure and were concerned about staying focussed on the core question; of prioritising their workload; and knowing when to ask for support.

> *So, the challenge was, yes, they [will] help me, but the research is supposed to be mine. I don't know how to ask for their help. I don't know when I should. So, I'm still in my first year, but all the articles I'm reading I'm getting a grasp of what it means. But at the same time, the imposter syndrome comes in again. I'm so scared if I will be able to understand all that is expected of me to carry out this [topic]. But the good thing is I'm enjoying it because it's something new and I'm learning a lot from it.*

And there is a limited time in a PhD. You have to decide what it is your focus is going to be and what you're going to do. I was already biting off more than I could chew because I want to do everything. I'm now in my last six months, and I still have things I would like to do. And I've been told I have to let them go. So, I'm really battling with that, because I don't like letting great ideas go.

One participant expressed the challenge of working independently as not feeling part of a team.

I think for me the biggest challenge was working by myself, not being part of a team, not really having anyone else to depend on. I have got my supervisor, but at the end of the day, all of my work is my work. If I take a week off sick or annual leave, no one else is there to pick up the slack and I've got to catch up on that work.

A few participants highlighted their underpinning career decisions as their main challenge. These ranged from concern that their proposed academic career was a hard career path to aim for through to complete commitment to an academic career, but not anticipating enjoying their doctorate after an unsuccessful masters degree experience. One participant noted that as a first-generation university graduate their challenge was in explaining the doctoral degree and their decision to do one to their family.

I was the first gen in my family to go to university, not even to do a doctorate, so I find this whole thing of expectations really difficult because, to be honest, I had no idea what to expect. My family, a lot of them don't understand what university is, no matter what a doctorate is, so I still get a lot of that as a challenge. I get them very questioning of what I'm doing.

6 Experience of their doctoral provision

Participants were asked about their experience so far within their doctorate. They were also asked to try and disconnect how their experiences had been impacted by Covid restrictions and their underlying doctoral education.

6.1 Induction processes

A common challenge raised by participants in all the focus groups related to understanding what was expected within their doctoral programme and feeling 'thrown in at the deep end'. Participants who were not in CDTs were more likely to report a lack of understanding of what was expected, especially if they were their supervisor's only doctoral researcher.

I feel like it's a little bit like there's not enough transparency around what the actual expectation is, or the outcome of the PhD or project is supposed to be with what's actually being delivered in terms of training and supervision.

My expectations about going to a PhD was that the supervisors would be the experts in a certain field. That they would develop you and train you and give you all the courses you needed. My experience has been, you get thrown in the deep end and you have to find out what you need to learn and find people that can help. It seems like the responsibility is thrust upon the students to deliver a PhD and deliver something for a company. And there doesn't seem to be any ownership or responsibility with the supervisor or the university.

We all know research is going to be challenging. All of the [cohort] above me before I started said, you shouldn't do it, you don't know what you're going to get into, sort of thing. But you do it anyway. I just thought the bureaucracy around the whole thing would be a lot more supportive.

A few commented on their induction process, with their experience extending from having a comprehensive induction to the extent of not being able to judge what was important/needed through to one who appears to have missed the induction process and it was not picked up. Two participants reported difficulties in being allocated desks (pre-Covid) and another on accessing a laptop (during Covid). One participant noted that having moved to a new institution for their doctorate they had unexpectedly found it challenging to find their way round institutional processes.

I appreciate it's your project, it's your research, you need to get it done yourself, but I thought we had different resources around us that we could access in order to help us, whereas very much at [Institution], it was you get your induction and you get the speech on day one of what to expect and where to go. And then you try and use those avenues if you get anxious or you need help with something and it's very lacklustre. There's no proactive approach to helping students. And I know the pandemic has heightened that, but it was there beforehand as well.

Two neurodiverse participants described challenges in working out how to access support services at the start of their doctorate. Both participants reported having to negotiate a support package by themselves through student services who had little understanding of the differences between undergraduate study needs and those at doctoral level.

As somebody who is neurodiverse, I see no help at all from the [Institution]. Everything I do takes me longer. And how can you do a PhD and assess a PhD for somebody who has different accessibility needs in the exact same way as somebody who doesn't?

Three participants gave examples of being allocated a buddy at the start of their doctorate. In one case this was someone outside of the department that who was helpful in guiding them through institutional processes, such as obtaining an email address and locating support services. Another was a 'social buddy', who was appreciated by the participant, but the relationship had felt 'forced'. The most successful examples appeared to be when the buddy was a current doctoral student or postdoc from within the research group and was very helpful in helping the participant navigate the department processes and how to access equipment, etc.

I can just say that for our CDT, we had a buddy system that if a year is above, they can be there for us if we have any questions or to guide us through the PhD, especially in the first year. That worked very well for us. [I also appreciated] the support that is provided inside your own PhD group from colleagues and the supervisors.

So in terms of the research group, our supervisor usually always assigns a person when someone new is coming. So, it's like a buddy system. So, we will take them, I don't know, to get their identity card, to sort out the laptop and this kind of stuff. And of course, since you always have students from [previous] years, they can always give you, like suggestions, some things to consider.

6.2   Supervision

Participants were generally very positive about their supervisory experiences, with many fulsome in their praise of the support their have had from their supervisors, particularly during the Covid restrictions. The positive supervisory traits highlighted were knowledgeable, supportive, flexible, engaged, available, knowing when to intercede and when to step back.

I'm just in my first year, but the kind of support my supervisors have provided me has always been very overwhelming. They're always there to help and guide and to answer any questions that I have, so I guess in that way it's been a really good experience overall.

With regards to my supervision, that's been amazing. And yes, I don't think I could ask for a better supervisor. I think I speak to him once a week. We have a dedicated meeting. And I know a lot of other people think, whoa, once a week. But it's really good and really useful.

Participants that were having a less positive experience described their supervisors as: disengaged, inflexible or directive. They recognised that the supervisory relationship could be 'the luck of the draw' and were aware of other researchers where the relationship was not working well.

I've had a number of issues with my supervisor in terms of him having a very fixed mindset of what should be done and not being willing to expand his ideas or expand the techniques that we used even if I've looked at the literature and I'm like, here is the state of the art. Here is what other people are doing. You did this 20 years ago, but things have maybe changed.

Those who previously had known their supervisor from their undergraduate research project or masters were likely to mention that knowing what to expect in the supervisory relationship had informed their decision whether to do a doctorate.

Participants were well aware of their dependency on their supervisor and noted the power imbalance if anything goes wrong. Those that had had difficulties with their supervisor talked about feeling isolated and having to work out any issues on their own without any support from their research group or institution. They were aware that their institution had formal complaint procedures but were reluctant to go down this route due to concern about the power imbalance and (perceived) possible consequences for their research and career prospects. One participant noted that they were aware of a route to raise issues within their CDT if needed.

I think something needs to be put in place by the [Institution] on their expectations of a supervisor and supervisor, supervisee relationships. I have friends whose both their supervisors are married. And how are they going to complain about one supervisor to the other supervisor? Or they have supervisors who are the head of the department. Where are they going to go if they want to complain? They can't.

And I know that a strategic challenge for [Institution] at the moment is overseeing research culture change. I think PhD students are at the sharp end of the power imbalance in academia. And if someone is struggling because of the research environment in which they're working, the idea of challenging an entire ecosystem, the

research environment, is so overwhelming that no one wants to do anything and so we have the status quo.

A few participants had changed supervisors during their doctorate because of their original supervisor moving institutions or taking maternity leave (before the project started). In all cases, participants described the disruption this had caused: of having to build new relationships, resulting confusion and lost time; sometimes involving a change in focus and in one case a change to a research topic not of their choice. Conversely, one participant noted that a supervisory change had resulted in a better fit.

I lost two supervisors to go to a different university and then had to replace them with two new supervisors. Only one of the supervisors who left transferred me to a new supervisor. But there was a whole time, probably three to five months where I basically wasn't supervised by anyone, and I wasn't given support. And I just don't think that's what I expected. I expected that the supervisors would kind of be a constant all the way through my PhD to help me and whatever. But yes, it wasn't ideal at all.

You also get this change of expectation when you swap over for supervisors. So, I went from quite a hands-on supervisor to a very hands-off supervisor, so I had to really get used to that. Not only did I have however many months without supervision, I then had however many months I had to get used to it and set out my expectations and they had to set out their expectations of me. So, it was very difficult, and I don't think any support was really provided for that.

Participants reported being supported by their supervisory teams through a variety of different arrangements (primary and secondary academic supervisors, co-supervision, academic and industrial supervisors). Not unexpectedly, the extent of involvement of different members of the team differed, however, some participants noted that in practice they effectively had a single supervisor.

Those with industrial supervisors were generally positive about the opportunities this provided them to engage with industry and access to internships.

If you have an industrial supervisor, you can have an internship or a different perspective of how you can apply your research and apply it to the industry and how the industry people think about the topics that you're doing.

However, the most common feedback on supervision was the challenge in balancing the different requirements from within the supervisory team, particularly between academic and industry supervisors. In all the examples described by participants, they talked about singlehandedly having to negotiate a path between these different expectations and ways of working.

In my case I have three supervisors. They are two from academia and one from industry. What I have found is, especially in the first year of my PhD, I found it to be difficult to find the balance because everyone has different expectations of you and you have your own expectations for how you want to go with a PhD and everything, so I think it can be a bit difficult at first, but I think the key is communication and finding out what everyone needs and also you should have your own voice into this.

6.3 Training and professional development

The majority of participants were positive about the range of training and professional development available to them across a wide range of topics delivered through a central researcher development programme or locally through CDTs. Those participants in CDTs mentioned the value of team-building activities for the cohort, with one participant strongly valuing the (pre-Covid) residential induction programme for both professional and personal development. One participant said that the advertised comprehensive training package was part of the reason they were attracted to their doctoral programme.

We had a series of training sessions provided by the university, such as training for using [equipment], for writing-up, scientific writing, communications, so on and so forth. Those are actually run very well by the university. In combination with that, there was the [Institute] who run a number of courses and some of those have been absolutely fantastic. There was the option to pick and choose between the different courses and that was actually very good. I enjoyed that and even dropped into a few additional ones just for fun like learning about possible life on other planets and some of the astrophysics topics, which have got nothing to do with what I'm learning, but it was on top of what I was already doing. So that I really enjoyed.

The personal development modules that are on for CDT is really interesting where you go away with your cohort for a few nights and just learn everyone's different and how to work in a team and then all the different modules alongside. I think it develops you as a person. But then also, it's interesting how there are so many other students on the cohort that are so similar to you and learn in the same way. And then how other people are just completely different and how they work well together.

So I'm in the [Location] and I think it was pretty clearly advertised that the aim of the CDT was to cover all of the different areas, so intellectual ability, public engagement skills, communication skills, presentation skills, developing all of that. So I was expecting a pretty well-rounded programme to cover all of that. I know that you have specialist courses from [institute] and then they organised specific training for public engagement. So I actually went into the CDT because I thought it would be a well-rounded programme covering all the different parts that are relevant there.

Some participants described access to training courses in other universities as part of their doctoral programme. They all appreciated the opportunity to meet with researchers from other institutions: the Scottish Universities Physics Alliance (SUPA) was specifically highlighted.

Participants appeared to have different obligations in terms of participating in training activities. A few participants talked about having to participate in a compulsory programme of training courses in their first year: not all of which were useful or applicable, leaving little time to participate in optional but more relevant courses. They expressed frustration at spending most of their first year in 'non-research' activities or research methods training that they didn't need. They suggested that some of the courses may be more useful in later years, for example learning about postdoctoral opportunities and careers advice. Other participants were required to achieve a certain level of 'credits' by participation in a selection of training programme of their choice.

Having to complete a masters programme as part of their doctoral training, despite already having a masters was raised by two of the alumni participants. Although initially they had not wanted to do this, they both reported the experience as valuable.

> *I also didn't love the idea that I would have to get a masters, because I was a bit older, I already had a masters, I'd started my career. But actually, that was one of the programmes that I enjoyed the most of the entire time that I was there, I thought I would hate it, but I actually ended up liking it. (alumni participant)*

> *My PhD was in a really specific focus of a component in the jet engine. But the MRes course taught us so much about the whole engine system that actually almost at least once a week I reference the notes that I had taken during my MRes class [in my current job]. (alumni participant)*

> *I feel like I would have expected to have more training in terms of also scientific writing or those sorts of things, which I really lack in my particular doctoral training programme.*

For some participants attending training courses was entirely at their own choice and one reported using their initiative to go outside the department to get the training they needed, while another "*had been able to expand my skills at my own pace and my own choice".* A few participants appreciated that their research groups/institutions were responsive to requests for particular training and would try to provide it. One participant described the use of an institutional online skills tool to assess their skill level and suggest courses to fill in the gaps; they found this very useful, but still difficult to work out what they don't yet know that they need.

> *I have been quite lucky because there's quite a range of opportunities that I've had, starting from teaching hours that I've been allocated but also a network of scientists that I have access to through my supervisors and through our research group and always this encouragement of collaborating with others and expanding my skills and knowledge with the help of others as well, which I think was extraordinary and it still and will continue to be in the years to come.*

> *The [CDT] programme has been very supportive for me. They almost go out of the way to ensure our mental and physical wellbeing. During Covid, they've been giving us constant pointers for access to mental health support, have been checking on us, video calling us and so on. So, they're very good. And even for extra career training, we are encouraged and open to suggest workshops, which we might personally attend. A lot of people mentioned teacher training. So, in case I want to do something like that, I could probably ask them, and they would direct funding to that to let me go and attend such a workshop. So yes, I am very comfortable and happy with it.*

There were mixed views on whether supervisors encouraged participants' engagement in professional development activities. One participant had made it clear that they wanted to continue participating in outreach activities through their doctoral degree and their supervisor supported them to do this. Another noted the value of courses being optional but when supervisors did not give permission or support participation, it could be difficult to get the time to attend.

So that I ensured that throughout the course of my PhD I've made sure that I am going to professional development events or I'm seeking out opportunities which aren't in the lab. And I can see, having spoken to a lot of the students about this kind of thing, particularly if you're working in a supervisory environment where you're expected to be in the lab eight until six every day, seven days a week, it's very difficult to pursue those. Unless you have very, very high self-motivation and the confidence.

Particularly when there's such a power imbalance in a supervisory relationship and if your supervisor is not actively encouraging you to do that because they have the survivorship bias from their own PhD, it's difficult to go and seek out those opportunities.

I personally found with my supervisor was quite sceptical of professional development courses and just had the view, you should be in the lab for your PhD, and didn't have a very positive view of development things. So, I generally found that quite difficult and slightly unsupportive

When asked what additional training or development would have been useful, participants mostly identified academic-related training, for example academic writing, presenting to academic audiences, applying for funding.

Several participants raised a lack of opportunity to develop their teaching, having expected to have access to teacher training and teaching opportunities to support their ambitions for an academic career. Others talked about working towards Fellowship status (FHEA) alongside their doctoral studies. Several participants noted that their supervisors actively involved them in academic activities, so that they had had opportunities for teaching, marking, supervising undergraduates and chairing research meetings.

One thing I did find really useful was doing some undergraduate teaching. We have the opportunity as PhD students to do lab marking and supervising and seminar marking and supervising. And it did add an extra component of work because, obviously, that's on top of your PhD hours, but I did find that very useful for developing more general skills and communicating more complex ideas.

6.4   Skills development

Participants were asked what skills and attributes they expected to develop during their doctoral studies. They were provided with the four domains of the Vitae Researcher Development Framework (RDF) as prompts. These are:

- Domain A. Knowledge and intellectual abilities: the knowledge, intellectual abilities and techniques to do research.
- Domain B. Personal effectiveness: the personal qualities and approach to be an effective researcher.
- Domain C. Research governance and organisation: the knowledge of the standards, requirements and professionalism to do research.
- Domain D. Engagement, influence and impact: the knowledge and skills to work with others and ensure the wider impact of research.

The skills and attributes collectively identified by participants covered the range of competencies described in the RDF as developed through the process of being an academic researcher (Table 1).

Table 1. Skills and attributes participants expected to develop during their doctorate.

Domain A. Knowledge and intellectual abilities
• Knowledge base
• Critical thinking
• Creativity
• Problem solving
• Data analysis, data mining
• Technical skills such as use of software and programming
• Research skills
• Experimental techniques
Domain B. Personal effectiveness
• Resilience
• Perseverance
• Independence
• Time management
• Self-organisation and self-discipline
• Working alone
• Work life balance
Domain C. Research governance and organisation
• Research process
• Project management
• Lab work and practice
• How to conduct independent research
Domain D. Engagement, influence and impact
• Working in a team
• Communication – how to present ideas and your research clearly, confidence in asking "*stupid questions*"
• Communication skills
• Academic writing, including for English as a second language
• Teacher training
• Mentoring and supervisory skills
• Public engagement skills

The importance of perseverance and resilience in the doctoral programme was a common theme across the focus groups.

I think the main one is patience and resilience because it's not related directly to the work, but I suppose the glue of the PhD is just to be patient and resilient.

I'd say doing a PhD requires you to learn how to be confident and stand up for yourself, I guess. I've dealt with a lot of difficult academics who… You can show them all the data in the world and they'll be like, that's rubbish, and a lot of people who will try and push you around and use the fact that they're more decorated academic to say, this is what I think and therefore, because I think it, it's right.

The ability to ask stupid questions. Especially when you are at a seminar, and someone is very knowledgeable about some subject, and they just keep going on and on and on and you just lose them after the first three minutes. I think it's a very important skill to be able to admit that you don't understand what's someone's saying. Because especially with Zoom it's very easy to pretend that you understand, and nod along and just phase out. So, I think that's an important skill that I've been trying to teach myself.

Many participants also commented on institutions' emphasis on good mental health and wellbeing and having access to a range of wellbeing courses, such as stress management, especially during Covid. A few noted the irony of these institutional messages in contrast to the implicit, or explicit, expectation of doctoral study requiring long working hours.

I [appreciated] my department during Covid, they actually had a survey that was checking out the wellbeing of everyone and seeing how everyone's wellbeing was changing through Covid. I struggled working from home, compared to maybe some of others. And when I told my supervisor, they tried to find a way as early as possible for me to be able to work in the department, which was safe, obviously. And those are the sorts of things that they tried to do. I think having the survey was really helpful.

Participants were also asked about what had been most useful in preparing them for their future career. Some participants talked generally about the 'transferable skills' they had developed that would be useful in their careers generally and particularly if they moved beyond academia (Table 2). The alumni participants identified a similar set of skills that they had developed in their doctorate that are most useful in their current career.

Table 2. Useful career skills developed through their doctoral education

Current doctoral students	Doctoral alumni
• Problem solving • Critical thinking • Time management and self-starting skills • Resilience and self-confidence • Perseverance • Communication skills • Dealing with difficult/demanding people • Collaboration and networking skills	• Project management • Research skills • Networking • Presenting skills • Defending your work • Working independently • Talking and engaging with people • Talking the language of the other disciplines

I feel like personal growth has been, for myself, the most important thing rather than gaining particular skills that I can apply in either industry or academia or X, Y, Z that I got to do.

One participant from a CDT said that their engagement with industry supervisors and placements had given them a good understanding of what industrial employers are looking for that was very reassuring. Another participant noted that not only do researchers need to know what employers are looking for, but they also need to know how to articulate their skills effectively to potential employers.

Yes, for me because I think I want to go into industry, initially when I started, I think we agreed on a one-month update with my industrial sponsor. However, my supervisor thought it would be awesome to have a bunch of universities come together along with my sponsor and chat about the specific research fields that we're doing. It started out once every week and it's now relaxed to once every two weeks. But it really gives me an idea of what industry wants. And then, not only my industry or sponsor, but we're bringing in other industrial companies as well who are related to it. So, understanding what industry wants, for me, has really put my mind at ease.

6.5   Navigating institutional support services

Several participants revealed they had suffered mental health issues over the previous year and their experiences accessing institutional support services. They brought into sharp focus the unique position of doctoral student sitting between student and staff. They described having to negotiate a path through to the appropriate services by themselves as it wasn't clear what they could access as a doctoral researcher. One participant reported that they had organised their own support independent of the institution rather than reveal their condition. They proposed that more targeted signposting for doctoral students would help them access services and be more open about their situation.

Well, it's probably affected everyone, but the impact of Covid on my mental health, and also even before Covid, I've always found that the department was very supportive. It was hard for me to access those things because I didn't realise which avenues to go through in my institution, because it was all coming quite new to me. But it is there and everything. It's quite new for my supervisors and everything to navigate as well. But I would say it was slightly difficult, but when I did find out the right avenues and the right way to do it, it was quite straightforward.

Sometimes I do like to have that distance between the university in a professional context and the university in a friendly, family context. There isn't someone who is non-biased. I think as much as everyone wants to say, yes, wellbeing comes first, in a lot of cases, I think there is that pressure from a funding body to say, you've got x-number of months for your project, you need to get it done. And I think it's that's that difficult toss-up. Not for you to make, but for your supervisor to make. The advice you'd get would be loaded, if that makes sense. It's loaded towards saying, yes, the project still needs to finish. That's the be-all and end-all of things. Whereas if you had an external person, it's like, actually, at the end of the day, the most important thing is you. I think that gives you that level of distance.

Circumstances that require a suspension of study was highlighted as a specific issue for doctoral students. One participant described being caught between continuing their doctoral study with a medical condition that impacted on their ability to work or taking a suspension of study that meant they had no source of income or other means of support and would lose their home. They reported the institution proposing "*they could go home to their parents*" when this was neither practicable nor appropriate.

It does seem like there's an assumption that you'll have family to support you if you struggle. Again, when I had my health problems, there was a, well, take a leave of absence, go home. It's like, that's not really an option. I think academia in the past couple of decades has obviously opened up more and more to more working-class,

less privileged people with scholarships and there's an assumption that you can still come and study, but there's still a financial barrier where people are… Yes, we're paying you, but there's also still an expectation that you'll have help from home or, if things go wrong, you can just be like, I'll take some time off. I think there needs to be more for these situations where people struggle.

Mitigating circumstances are often available for undergraduate students, but not postgraduate students. Because you've got this timescale for your stipend and you are only allowed this suspended, but then you don't get paid for it and vice versa. I had a deadline [first-year probationary report] during which I had Covid, and I asked if I could have it extended. And they were like, no, we can't, I'm afraid.

6.6 Meeting and exceeding expectations

Participants were asked whether their doctoral experiences had met or exceeded their expectations (excluding any Covid-related disruption).

Several mentioned the challenging but rewarding opportunity to work independently. Another had expected to be supported to set up in the first few months then left alone: instead they had received welcome ongoing support.

I'd say one part I've really loved has been, there's nothing more satisfying than when you have an issue, and you manage to fix it yourself. There's just something very satisfying about going to your supervisor and it's results they don't expect, or they're impressed by. I really love that process of problem-solving and then inevitably the next problem comes, problem-solving. That has been really good.

Many commented positively on training opportunities, noting that they were well-advertised and exactly *"as billed"*. One said they were "*pleasantly surprised by the amount of university training on offer".* Participants described the benefits of being part of a cohort and connecting with industry.

I can speak from the experience of being in the CDT. We had five cohorts of PhD students and I was in the third cohort. So, the middle children. But we had people who came before us who could give us a lot of experience and make us feel welcome. But then we also had new colleagues who came in who were people I've collaborated with, people with whom I've become really good friends.

My CDT was four years and the first year we have a rotation project that we do in industry… So, I really enjoyed that part of the PhD because it gave me the opportunity to experience how the industry works, and also a taster to, later on, show me what exactly I want to do. It was a good experience.

Participants provided examples of where their experiences had exceeded their expectations. They most frequently mentioned opportunities to work on cutting edge research alongside leading researchers and to collaborate with researchers in other countries. One noted that international collaboration opportunities had changed their research for the better. Others said that their supervisors have been more supportive than expected and the administrative support from their institutions and supervisors was reassuring and appreciated.

Turning what I said previously into a positive, the fact that I ended up going and finding [another supervisor] I'm actually in the department which is [working on Covid]. I am with some very highly published researchers and I'm able to learn from them. They're not directly in charge of me. I just happen to work in the same lab space as them. So, access to having experts in a variety of different backgrounds right next to me has been fantastic. That has really made my life much easier with regards to my research. So that was completely unexpected.

The university treats people very differently from what I have previously experienced in [other] universities. The staff are very approachable, very friendly, very helpful. It's just been completely great. Anytime you need help, you don't always have to learn a whole technique to do something. If you're going to do it all the time, yes. But otherwise, you collaborate with each other and everybody's just very willing to put some time and effort in for you. It's a very collaborative and rewarding environment. I didn't realise how enjoyable it would actually be. I knew there'd be pain, but I didn't realise how much fun there was. It's been a roller coaster, but a great ride.

One participant commented on the excellent support they had received from their institution in registering a patent and how to commercialise their research. An international researcher noted that they hadn't expected all the support for wellbeing and mental health and had found both the content and availability good.

The alumni participants all described their doctoral programme as a positive experience. They highlighted the value of working independently; enjoying the process of figuring things out for themselves and could see how this has been useful in their current careers. Their doctoral experiences had prepared them to take initiative and empowered them to make decisions. Two alumni felt that the doctoral process had helped them to manage conflicting priorities either by having several supervisors or having industry and academic partners. One participant described the challenge of the different cultures and that they had learned the process of how to understand and navigate these.

6.7   Challenges

Participants were asked about what they had found most challenging during their doctoral studies (excluding Covid-related restrictions). Knowing whether they were achieving sufficient progress and worrying about not working hard enough were mentioned by several participants. A few mentioned the difficult of setting and achieving deadlines and getting a balance between research and writing.

I'd say it's been talking to other PhD students that gave me a realistic expectation. Just keep going, keep going, keep going. And many times, you feel like you are going in circles. You keep going back to the previous thing that you thought. But once a friend told me it's not the circle, it's actually a spiral. You think you are going back, but time by time you will end up into your goal. Don't take anything too much seriously. Just keep going and eventually you will get there.

I feel like it's a little bit like there's not enough transparency around what the actual expectation is, or the outcome of the PhD or project is supposed to be with what's actually being delivered in terms of training and supervision. I've had this both at

[Institution] and now [Institution], and it seems to be a common theme amongst other PhDs as well.

I think independent research is one thing but having to jump through hoops so you can do it is a different thing.

In contrast to those who enjoyed their independence, several participants had expected more autonomy and control over their work, which was largely decided by their supervisors. One noted "*that it makes it hard to defend the thesis since it does not feel like your own work/choices*". Another participant's supervisor did not have expertise in their research area and they "*had to be entirely self-starting*". Several participants mentioned challenges in setting up and running their projects, for example in defining their research parameters, and in balancing conflicting industry requirements. An underpinning theme within these challenges was uncertainty of the expected outcomes needed to get a doctorate.

Most alumni participants reported that they had struggled to complete on time and had had to take additional months. One felt that this could have been mitigated by more access to his supervisor during the writing up process, particularly having a faster response to thesis drafts and suggested that there should be guidance and limits on numbers of researchers that they supervise.

7   Funding and status

The level of funding for doctoral degrees and the status of doctoral students emerged as key issues, with particularly animated discussions in two of the focus groups.

Several participants commented that the level of the doctoral stipend was too low to live on and they had to supplement it through taking part-time employment either within the university (teaching, marking, demonstrating) or externally. One participant noted that they were unsure whether this work was allowed within their funding and reluctant to find out in case it wasn't. One international participant described having to decisions on basic spending as their visa conditions prevented finding employment to supplement their stipend. Another noted that there is a presumption that all doctoral researchers are young, single and have access to parental support: there is no consideration of having to support a family on a doctoral stipend: current stipend levels are off-putting to those returning to academia as mature doctoral students. They discussed whether the different costs of living across the UK should be considered when setting stipend levels and noted that the current London uplift was insufficient to compensate for the higher living costs.

In the first year, for example, I could either pay my rent or have three meals a day. And don't know how to justify this. So, I had to work at least one or two jobs within the universities to boost my financial income so I can sustain my, I wouldn't say lifestyle. Lifestyle would be something different, but to eat and to pay my bills, for example, let's put it this way.

Participants asked why EPSRC awards were not consistent for all their doctoral students since having different levels of funding and different lengths of funding (3 or 4 years) within a research group created discontent. There was some confusion as to why institutional policies required doctoral students to complete within 4 years, but some stipends only covered 3 or 3.5 years of funding. Some of the reported differences in funding levels may be

explained by individual participants receiving uplifts from their industry sponsor, but it was not possible to explore these concerns about differential funding in depth within the time for the focus group.

All of the alumni participants agreed that the length of time for the doctorate was unrealistic leading to a gap in funding and stress towards the end of the programme. They noted how this was a particular issue for non-UK citizens with their visa ending after the four-year period creating even more of a pressured environment where they struggle to finish on time or have to complete from their home country. Many of these students are traditionally older and this has effects on spouses/families. One described how they had moved to the UK with their family to undertake a PhD without being in possession of the full facts regarding how long it would actually take. Another noted that as they had been on a 1+3 CDT programme, they did not qualify for any form of extension.

> *So, in terms of life planning, I would have rather known what to expect for my life. (alumni participant)*

Participants also raised issues with the entitlements included within their funding. They proposed that, given their position in research groups and their contribution to research outputs, they should have access to the same benefits as staff within the institution. Participants mentioned better practice around maternity and paternity pay, accruing pension benefits, entitlement to sick pay, formal holiday entitlement and agreed working hours. However, students were largely unaware of the provision EPSRC already has for such support under the funding terms and conditions.

> *If I was to start a family, for example, I wouldn't even know what the procedure would be and somehow, I doubt it would be anything other than taking unpaid leave. That is something that is important to me. It did play a factor in planning my life as well, pushing back having a family until after my PhD. So, it would be good if there was maternity and paternity support during your PhD.*

There were strong views from a few participants that doctoral students should be employed as staff as happens in many European countries, for example, The Netherlands and Germany. They described the status of doctoral students in the UK as falling in a "*grey area*" between staff and student. One participant believed that more policy statements would not improve doctoral students' working conditions and there needed to be a legal requirement for institutions to provide fair treatment through employment law.

> *I still feel very much like a student in some ways, which I am. But it's like you get the best and worst of both worlds and feeling the worst parts of being a student and the worst parts of being a professional at the same time.*

> *I hadn't quite realised how much of a grey area PhD students are between staff and students. So, sick pay, we don't get, and if you suspend, you don't get paid. It's difficult. I've been working with a dislocated hip before. When I had Covid, I just did work at home. Luckily, my supervisor is very understanding, but there's not a system. We're in a grey area very much.*

However, there was also recognition of EPSRC funding enabling them to undertake a doctorate, which they otherwise would not be able to do and investing in speculative research.

So, in my particular case from the lower-middle class background, I have absolutely no support from parents whatsoever and I would never have been able to have done a PhD without the support and funding from the EPSRC. So, it does offer an opportunity for those from lower-class backgrounds to do a qualification such as this, particularly at a university like [Institution]. So, I think the EPSRC is definitely helping people from lower backgrounds who have skills and abilities to actually take on those jobs and roles rather than it just being the realm of those who can afford it out of their own pocket. So, I think they've done a good job with that.

I think I can speak for a lot of my friends on the same programme, and as foreigners, to come to the UK for the first time, and being exposed to a wider range of academic and industrial partnerships in the EPSRC programme is incredibly valuable for us. And that matters so much for our professional and personal life here. (alumni participant)

My project was an exceptionally high-risk project. You will not get funding from a private source or a company for that. The fact that the EPSRC funded it meant that the research could go ahead. I've got the training and I'm staying within the field, which I think is a success. The group I'm moving to is continuing that research.

8 Preparedness for career choice

Participants were asked how well prepared they felt for their future careers. For most of the first-year participants it was too early in their degree to answer this question and for others, some were "*focussing on their research and would consider their next step later".* For those who had thought about their next step, responses generally differed between those aspiring for an academic career and those who aspired to work in industry.

I think the CDT structure, at least for me, is really helpful in preparing us, both for academic and industry jobs. Because there are various formal links with us and lots of other institutions. It means there's regular contact between us and specific people we can go to, to speak to and ask questions or get advice or internships, things like that. Having those longstanding relationships existing there for us is really the thing that I think is the value there.

8.1 Academia

Participants who were considering an academic career were most likely to say they felt well prepared and knew what to expect. They were most likely to raise concerns about whether this was a sensible choice, citing the difficulty of achieving an academic career, the lack of career progression paths, financial insecurity, and poor research culture. There were a few participants who noted that they didn't feel they had developed their teaching abilities.

It, obviously, depends on where I want to go into because I'm not exactly sure yet. It's quite hard to answer, but I feel probably more prepared to go into academia than I do into industry. And that's just because I feel like I'm in a CDT and I'm surrounded by academics every day. All my colleagues are academics. I feel like I'm more in touch with the potential to take up an academic job afterwards.

I'm quite interested in a career in academia. Maybe if all the problems, like ridiculously low pay, get ironed out. But one thing that is very obvious to me is that it's maybe not

so hard to go from PhD to postdoc, but then from postdoc to permanent position is very difficult, at least for the postdocs I've seen in our group. I don't think any of them made it through. So, maybe some sort of pathway. I guess you get fellowships for that kind of thing, but some sort of structure of how to get from a postdoc into a permanent position within a university.

I don't necessarily feel like my PhD programme in the CDT has prepared me to, for example, become a lecturer. I often have tried to scope out those opportunities myself and have stayed in touch with people who I've worked with during my undergraduate degrees to get some teaching experience. But my PhD programme hasn't really supported that, I, kind of, just went out and found that.

One alumni participant, who now has an academic position, when asked whether they would have valued more contact with EPSRC during their doctorate noted that having more understanding of how EPSRC works and the process of applying for and winning grants during his PhD would now be very useful.

I think I would have benefited from more of an understanding, more engagement with EPSRC during my PhD, because it would have meant that I wouldn't have had to go through some of that learning during the day job. (alumni participant)

8.2 Beyond academia

Participants who were considering careers beyond academia overwhelmingly talked about working in industry. Those participants involved in research with industrial partners highlighted the insights that these relationships provided through contact with organisations and individuals beyond academia. However, one participant noted that *"you need to be self-starting to take advantage of these opportunities"*. A few participants mentioned the value of attending talks on industrial careers organised by their CDT. One participant had had the opportunity to talk with doctoral graduates who had stayed in academia and who had moved outside and had found it very valuable. Another had been inspired by working with lots of people who had taken different career routes.

In terms of going into industry or a non-academic role, as a consultant, for example. I wouldn't really know where to begin. What has been useful, maybe going back to the collegial atmosphere I've been very lucky to have in my CDT, I do know former PhD students who went into that who I could reach out to.

Something that I was not expecting is that there are a lot of projects at the university that are in collaboration with industry. So, I have collaborated in a couple of those projects and it has been quite a great experience because you get to know what impact your research can have in the real world, whatever they call it. Also, you get to tailor the way you work to the way that is expected in industry. So, for instance, in industry what we found is that the pace is faster and also, they are less interested in theories on that stuff. They are more interested in the results.

I'm definitely making the right kind of contacts. I'm attending the right kind of events. And I tried to get into this field beforehand without doing a PhD, and for three years, I struggled. So, I think by doing it, doors have already started to open which hadn't beforehand. So, it's definitely going in the right direction.

8.3   Value of the doctorate

Participants generally recognised the value of the doctorate to all career choices, noting that it is very different from undergraduate/masters training requiring a different way of working that develops a different skill set. These *"researcher skills"* are transferable and useful for many career paths, with employers' valuing a doctorate even if the subject is not relevant. One participant suggested that the pressure of doing a doctorate prepares you for anything. Another noted that having a doctorate "*opens lots of doors",* while another cited data that showed having a doctorate could "*help you climb the career ladder faster than those without, because of the skills it provides".*

> *I think definitely, the PhD experience has really prepared people for whatever career path they want to. For example, if I'm looking for a research-based job in industry, then most of the good companies do require you to have a PhD. Some of them even require you to have one or two years of postdoc experience, because that's what they value more in terms of leading independent projects, trying to do independent research and so on. So, I think it does prepare you quite well. Even if you want to stick to academia, this is the path you have to take anyway. So, I think the PhD does prepare you for both the options.*

> *I'm privileged enough to come from a family where I'm the second-generation PhD student as it were. But I was very lucky to have the perspective that while one of my parents did a PhD, they did not work in academia. For me, that's why I think I had this expectation beforehand that a PhD could, with a valid career option, not necessarily pursue an academic career subsequently. Which I think has been, for me personally, a really important way to see doctoral training as a whole.*

Very few participants had sought formal careers advice from their careers service, despite a general acknowledgement of the value of careers advice. Most knew that careers support was available in their institution and they could call on it, but some thought they were more focused on undergraduates. Participants noted that it would be good to have their career in mind, but there didn't seem to be a 'right time' to offer careers support. One participant suggested that careers advice before taking the decision to do a doctorate would be useful, as undertaking a doctorate is as much a career choice as moving straight into employment.

> *So, I don't know whether it would have been nice to have had that conversation with a supervisor or a careers adviser or something. I don't know. Maybe it would be nice if the university would force me to have a session with a careers adviser, so I'd actually have to be forced to think about it. But yes, I just find because you're so focused all the time it is quite difficult to decide what you want to do.*

> *On the point of when you'd want to have career advice, I think even before the PhD, near the end of the masters is an important place to put it. Because a PhD is a time investment. And especially if you want to work outside of academia. I think it's important to consider whether it's a worthy investment of your time at that point for you personally.*

One alumni participant said that they had not received any support in moving on to the next stage in their career and felt the combination of a lack of a set end-point and the punishing writing-up process had meant that this was neglected. They would have liked more support

in developing their future plans. Most of the alumni participants agreed with this, highlighting the difficulty of writing-up whilst finding a job.

One participant described the value of the doctoral experience in terms of personal growth.

I grew up as a person and gained some skills of discipline, endurance, persistence, and also how to learn from my mistakes when things are not working for months and months, how to push and do my best. I feel like those skills are so applicable in whatever you do, regardless of which environment you go afterwards, and I think this is what matters the most. PhD is such a big personal growth as well, rather than just pure science and papers you publish.

9   Potential institutional interventions

Participants were asked to propose changes in how institutions deliver their doctoral education based on their experiences.

9.1   Better signposting of doctoral student support

Participants reiterated the challenge of navigating institutional services from their uneasy status between staff and student. They would value clearer signposting of the services they can access and how to access them. This was particularly highlighted for mental health services where participants recognised that there was good provision but struggled to access these. There was confusion between whether they should access student or staff services.

Again, it appears that this is part of that problem with that grey area between staff and student that you all sit in, where there seems to be a lack of clarity around what's available and having consistency and so on that would be different if you were either staff or undergraduate student. Because I think in some cases we can go to the staff and student services, and then there are some cases where we can go to neither.

I think a bit more support in the first year, especially for CDTs. It's great the way it is, but I think a bit more support in terms of maybe learning new tools, help around studies, help around labs, for example. Because it's really hard to get around technicians at the start, to get to understand how the lab works, what expectations are there from us. More opportunities to learn these tools that are going to help you later on.

Another thing that I think I would have found useful is signposting to certain things. I have support, but it's almost as if I've sourced it myself. I think in a lot of cases, there are certain things that just aren't talked about, and you are paying a lot of attention to how your supervisor might react to certain things. If stuff like that was maybe discussed a bit more openly, I would have personally found that useful. So that I wouldn't have had to seek out certain things myself and take a risk of telling my supervisor about my disabilities.

For participants who run into supervisory difficulties they proposed having a senior advocate who could help counter the power imbalance in the supervisory relationship and facilitate a resolution without having to go to a formal complaints process, which also should be more accessible.

Participants appreciated the comprehensive training and development provision provided by institutions and would value more guidance on how to identify what is most relevant to them personally. Some participants also requested easier access to teacher training and teaching experience to better prepare for an academic career.

Several participants noted that there is still an assumption from some academics that a doctorate is solely a route into academia and institutions could do more to change the culture to one that values the applicability of the doctoral degree to wider employment opportunities and for academics to actively encourage doctoral students' participation in professional development activities.

> *I think in a number of academics' minds, a PhD is a step towards basically being an academic and therefore all of your time and effort should be made into being an academic. So I think in terms of that preparing thing, it would be to normalize and ensure that supervisors and people in high positions are supportive of an approach whereby you're developing a broad range of skills that will be useful in a career in academia but can also set you up differently.*

9.2 Building communities

Participants suggested institutions could do more to build active researcher communities within institutions, particularly to integrate those doctoral researchers who may be isolated. They noted that academia could be more collaborative and less competitive, with the drive to publish restricting research progress through a focus on quantity not quality.

One alumni participant, who is employed by one of their CDT's industrial partners talked about the strength of the community within their CDT and how this had now extended into their working life.

> *The camaraderie. And the back and forth that you get to have with your cohort, who are all doing sometimes slightly different projects, working on slightly different technologies, different universities. And that kind of camaraderie for me has extended on now into our work environment now, because a lot of those people still work in the supply chain of what we do. Most of the research projects that I have at the moment are done with, or carried out with, most of my friends that I met through the [Institution] or CDT now.* (alumni participant)

One alumni participant described not enjoying the sense of competitiveness between the two institutions within their CDT, which was also reflected in the comments of two other alumni participants.

> *You often felt, or it was even expected, that you would get a hard time, from a questioning perspective, on your research from that rival university.*

Other alumni participants reported that they had not had much opportunity to network with the other institutions in their CDTs but when they did, they found it to be a positive process in which you were encouraged to share and support each other. One alumni participant in a multi-institutional CDT with a common first year programme described the value of being part of a cohort across institutions. CDT from an outside perspective -

…having that group of people that you're going through that first year with. And then even though you're all doing completely different things afterwards with different supervisors after that we still were together as a group.

One participant who had not been in a CDT, described the CDT as 'very cliquey' and that it had been impossible to interact with the CDT doctoral students if you were 'on the outside'. Alumni participants who had been in CDTs acknowledged that this could be so.

10 Potential EPSRC interventions

Participants were asked how EPSRC could improve their doctoral provision. A wide range of options were suggested covering the funding levels, status of doctoral students, requirements on institutions and engagement activities. Apart from providing funding, participants were mostly unaware of how EPSRC shapes their doctoral education. Some suggested changes are within EPSRC's remit to change, while others have far-reaching implications and require systemic changes.

10.1 Funding and status

There was a strong call for EPSRC to provide consistent and appropriate level of funding for doctoral students for the full four-year period of the degree. It was noted that comparison of the doctoral stipend (recognising it was tax-free) with average undergraduate/masters starting salaries was a disincentive for doctoral study. They acknowledged the privilege of being funded to do something they were passionate about and great personal development opportunity but suggested that this isn't something funders should take advantage of.

Most of the focus groups referred to the EDI implications of current funding levels discouraging and disadvantaging mature returners, people with family responsibilities and without other forms of support.

In two of the focus groups there was also a call for doctoral students to be employees or to have the same rights as employees. This was seen as a way to ensure access to appropriate maternity/paternity leave, sick pay and suspension of study, holiday entitlement and pension rights.

One of the focus groups discussed the lack of recognition of doctoral students' substantial contributions to research outputs and proposed that these contributions should be recognised through the Research Excellence Framework (REF). It was proposed that EPSRC should ensure that doctoral students get appropriate recognition of their contributions as named first authors.

An alumni participant questioned the distribution of EPSRC doctoral funding across institutions, considering the current practice as putting non-funded institutions at a disadvantage when competing for new funding and thereby creating a distinct divide in the sector.

10.2 Policies

Few, if any, participants were aware of EPSRC's (or institutional) existing policies relating to doctoral education. They called for EPSRC to issue guidelines on how supervisory relationships are set up, managed, and monitored. They suggested defined roles for different

members of supervisory teams, requirements for supervisory training and limits on the number of doctoral students for each supervisor.

Similarly, participants were unaware of EPSRC's commitment to inclusiveness and their EDI strategy and, for example, called for EPSRC policies on maternity/paternity leave.

Participants called for EPSRC's training and professional development requirements to require flexible and personalised programmes that evolve to meet individual needs. They proposed that progression processes should include personal development as well as research progress.

> *The number of different ways that individual departments do progression monitoring is not ideal. And I think even more so because it's academically-run progression monitoring and it's usually a short interview about your academic progression. They don't care about those questions of career development, personal development. You just spend the whole time talking about those first things.*

There was a degree of scepticism that having policies was sufficient to change institutional practices and posited that EPSRC has a responsibility to ensure that policies are followed and to engage with doctoral students to understand their experiences on the ground.

Alumni participants were very positive about the aim of the CDT programme to bring academia and industry together.

> *I think forcing universities to work with industry and doing research not just for the sake of research, but research that matters, is incredibly impactful for making a change in the world. I think the UK is really spearheading this applied research to make an industry better. So, kudos, and I thought the CDT was just a really good way for them to do that.*

10.3 Engagement and feedback

Participants were generally shielded from EPSRC through the filter of institutional provision. Apart from a few participants who recalled completing annual reporting requirements, participants reported that they had no relationship with EPSRC. When asked what relationship they would like to have with EPSRC they suggested the following activities.

- Provide more clarity on what EPSRC hopes to achieve from funding doctoral education and what they expect from the doctoral students they fund. They should distinguish between EPSRC and institutional responsibilities, making this clear to doctoral students.
- Create a community of EPSRC doctoral students, providing opportunities for them to network and meet professionally and socially through an online platform, conferences, and physical events. The Three Minute Thesis competition was suggested as way of profiling EPSRC doctoral researchers and bringing them together. Participants suggested that these activities would provide valuable opportunities for collaborations, although there were contrary views that it was not EPSRC's role to organise events.
- An alumni participant highlighted the importance of sharing outputs and data and EPSRC could do more to encourage researchers to prioritise this and support the process, while addressing the issue of open research and IP especially for industrial partners.

- Provide a periodic newsletter with useful updates, research news, jobs, and funding opportunities, and showcases EPSRC doctoral students' work targeted at the EPSRC community.
- Develop mechanisms for getting feedback directly from doctoral students through confidential surveys. Exit interviews with outgoing doctoral graduates were proposed to get honest feedback as there was "*no risk of comeback*". However, there was also a plea not to obligate any additional reporting on top of what was already required.
- Include doctoral student representation on the oversight of EPSRC doctoral programmes, including this current review.
- Participants noted how useful it had been to participate in the focus groups and hear about other doctoral students' experiences.

I guess one thing I'd say from today, just having some way to communicate with other EPSRC students because from this I've seen how many perspectives there are, how many different situations there are. And a lot of the time you're in a bubble where you think certain things are just how it is because that's how it is in your uni or your group. And I think it's been really useful to just hear other people's perspectives. And also get that validation that you're not the only person who feels one way about certain things.

11 Summary and conclusions

The focus groups were conducted during ongoing Covid restrictions, which inevitably coloured participants' views particularly for first year doctoral students who had spent all their doctoral studies under Covid. Nevertheless, doctoral student and alumni participants were willing to talk about a wide range of topics relating to their doctoral studies.

There was a fair level of consistency across the focus groups with respect to the main themes emerging from the discussions. However, each focus group had its own flavour with differing degrees of emphasis on the discussion topics depending on the balance of participants' views within a particular focus group. Nevertheless, a series of key themes emerged that are worthy of further consideration within the review of EPSRC's doctoral education.

11.1 Status and funding of doctoral students

The status and funding for doctoral students emerged as the most critical theme from discussions. Particularly two of the focus groups had animated discussions on whether doctoral researchers should be students or employed as staff. They expressed confusion over the different lengths and levels of EPSRC stipends, suggesting there needs to be more clarity and consistency within and across funding schemes and matched institutional scholarships.

There were calls for better associated stipend benefits, including sick pay, holiday entitlements and pension entitlements. A few mentioned the difficulties of suspending their studies due to ill health while having no alternative source of income. Particularly attention should be paid to benefits that facilitate equality of access to doctoral education for disadvantaged groups and those with particular circumstances, such as maternity/paternity benefits and family allowance, adjustments for disabilities, etc.

11.2 Influencing institutional provision and practice

Participants believed that EPSRC could influence changes at the institutional level through stronger policies and requirements within their conditions of funding. There was general scepticism whether institutions or supervisors would change without having external pressures. They were also generally unaware of existing EPSRC policies, for example relating to maternity/paternity benefits, training requirements.

Predominately there were very positive messages about supervisory relationships and some heartfelt gratitude of the support they provided during Covid. However, there were examples of supervisory issues where participants struggled with the power imbalance and finding resolution. Some participants also noted a lack of recognition from supervisors of the benefits of professional development and not valuing the time invested in developing researchers' broader competencies.

Participants were generally positive about the range and quality of the training and development available, but some requested fewer compulsory courses and more flexible provision with the ability to create personalised development programmes. There was some debate about the value of 1+3 model. They appreciated the wider skills and competencies developed during their doctoral studies, particularly being able to work independently, perseverance and resilience, and recognised the usefulness of their doctoral skills across a wide range of employment opportunities.

Falling into a grey area between student and staff, participants reported struggling to understand which institutional services they could use and how to access these. Particularly, highlighted were accessing student support and mental health services where clear information targeted and signposted directly at doctoral students would be helpful. A few doctoral students spoke about mental health issues during Covid.

11.3 Industry and business engagement

Those doctoral students who have had significant engagement with industry were positive about the opportunities this presented, particularly to make more informed career decisions by learning more about what companies are looking for from employees, their working cultures and job opportunities.

11.4 Attractiveness of an academic career

There were strong views on the attractiveness of an academic career, with perceptions of job insecurity, lack of career paths, low pay, poor working environment and a highly competitive culture discouraging participants from a career in academia. Even those participants who definitely wanted to be an academic acknowledged that they would be working in an unhealthy environment; aiming to find a good research group that would shelter them from the wider academic culture.

11.5 Building the EPSRC doctoral community

Participants reported having almost no contact with EPSRC, other than their funding. A consistent theme across all the focus groups was interest in having a stronger relationship with EPSRC. They proposed that EPSRC could engage more proactively with their funded doctoral students, for example, through providing newsletters, events or online platforms to

leverage the potential of the wider community and facilitate opportunities for collaborations. They proposed that EPSRC should set up ways to seek confidential feedback from their doctoral students, for example, through survey or exit interviews.

Appendix 1: Focus group questions

Doctoral student focus groups

The doctoral student focus groups were designed to gather the views and opinions of participants' doctoral education in relation to four areas:

- Their expectations for their doctoral education.
- Their experiences of their doctoral education.
- Their preparedness for their preferred career path, including knowledge and skills.
- How their doctoral education could be improved.

Participants introduced themselves, where they were based, described their doctoral topic, and what motivated them to a doctorate.

Expectations of the doctorate

1. What did you anticipate enjoying and did you think would be the main challenges?
2. What did you expect would be provided during your doctoral training?
3. What skills and attributes did you expect to develop as a researcher? (using the four domains of the Researcher Development Framework as prompts).

Experience of the doctorate

4. So far, how have your doctoral experiences met your expectations? What has been better than expected? Are there any disappointments?
5. What opportunities have you had during your doctorate e. g. for developing as a researcher, skills training, cohort activities, secondments, wider activities? How do these differ from your expectations? What have you not been able to do?

Preparedness for future career

6. To what extent do you feel your doctoral experience has prepared you for your future career? Give examples of the knowledge, behaviours, and skills you have developed that will be most useful to you.
7. Which specific aspects of your doctoral experience have been most useful in preparing you for your next step in your career?
8. What more could be done to help prepare you for your career?

Potential Improvements

9. What could EPSRC do to improve their doctoral provision?
10. What more could be provided by your institution, e.g. training courses, careers guidance, wider development activities?
11. What more could be provided by your department/supervisory team, e.g. access to training, research culture and personal wellbeing, cohort-building activities, supervisory support?

Any other issues

Is there anything you would like to add that hasn't already been discussed?

Doctoral alumni focus groups

The doctoral alumni focus groups were designed to gather the views and opinions of participants' doctoral education in relation to four areas:

- Their experience of their doctoral education met their expectations
- How prepared they felt for their preferred career path, including develop of knowledge and skills
- How their doctoral education could be improved.

Participants introduced themselves, where they were based, described their doctoral topic, and what motivated them to a doctorate.

Ask each individual to introduce themselves, describe what they are doing now, briefly their PhD, graduation date and at which institution. What was their experience of doing a PhD and how did that match to their expectations?

Experience of the doctorate

1. To what extent do you feel your doctoral experience prepared you for what you are doing now and what you plan to do in the future?

Preparedness for your future career

2. Which specific aspects of your doctoral experience have been most useful in preparing you for your next step in your career, eg training courses, placements, network building, careers guidance?
3. What more could be done to help prepare you for your career?

Skills and opportunities during your PhD

4. What knowledge, behaviours, and skills did you develop during your doctorate that have been / will be useful to you in your career? (reference the RDF domains)

Potential Improvements

5. What can EPSRC do to improve their doctoral provision?
6. What more could have been provided by your institution, e.g. training courses, careers guidance, wider development activities, research culture and personal wellbeing, cohort-building activities, supervisory support?

Any other issues

Is there anything you would like to add that we haven't already discussed?

# Appendix 2: Demographic profile of participants

Doctoral student participants

The demographic profile of doctoral student participants of the focus groups is presented against the EPSRC doctoral student population by:
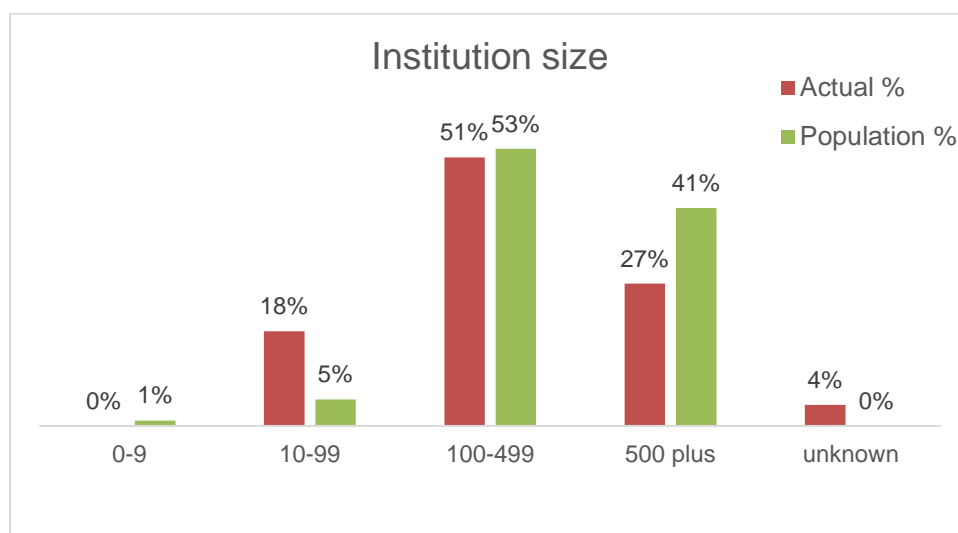
1. Funding scheme
2. Size of institution
3. Year of study
4. Discipline
5. Gender
6. Ethnicity
7. Disability
8. Age.

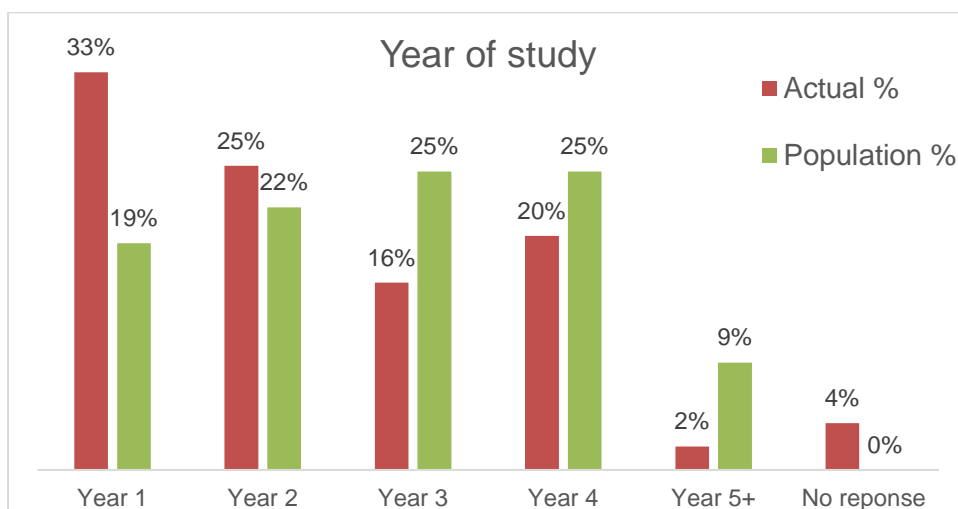A list of participants' institutions is also provided.

1. Funding scheme
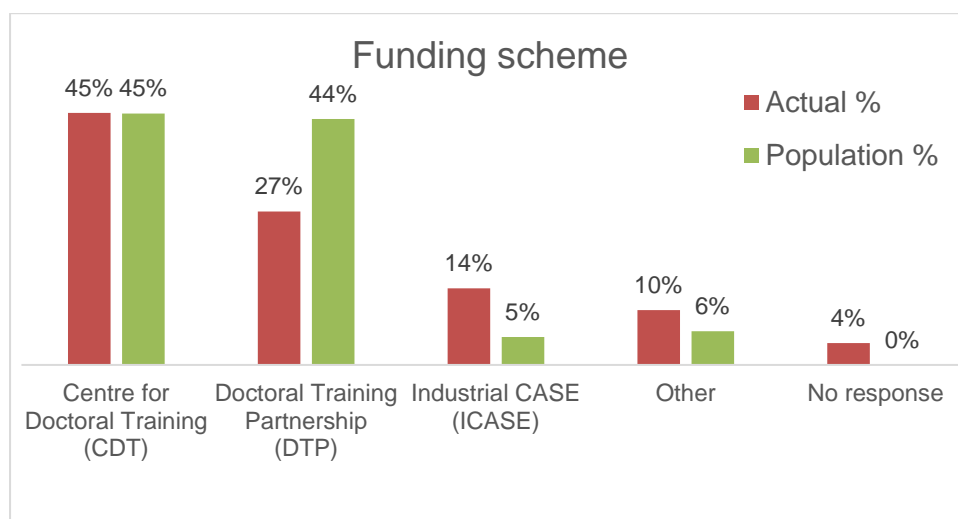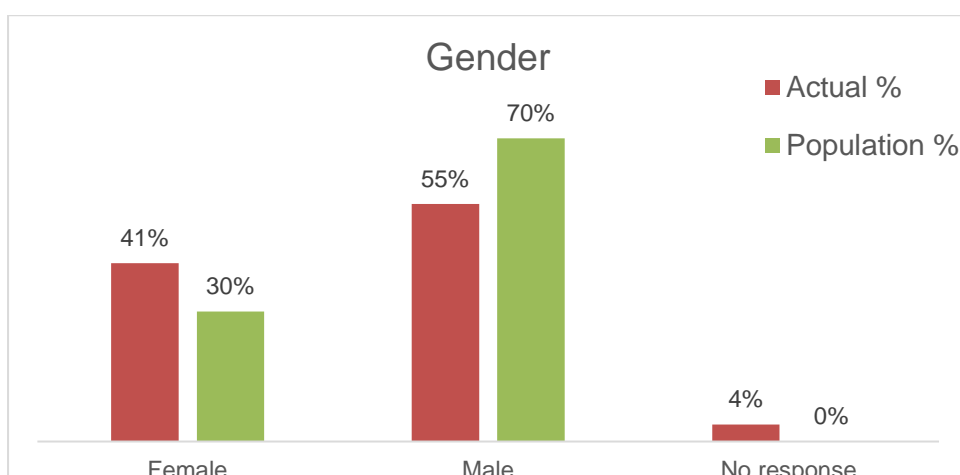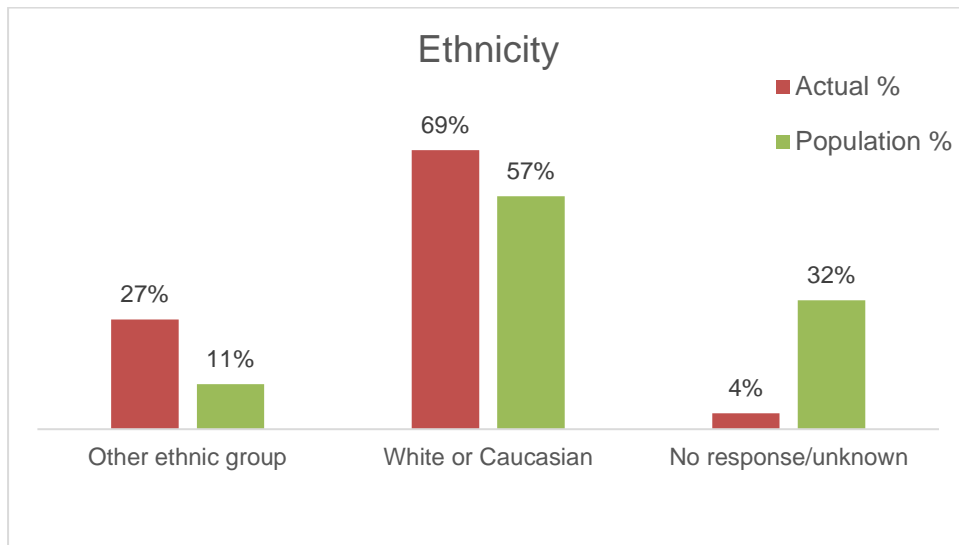

2. Size of institution

3. Year of study

4. Discipline (population not provided)

Discipline	Actual
Architecture	2%
Biology	2%
Computer science	6%
Digital Economy	4%
Energy	4%
Engineering	47%
Healthcare technologies	2%
ICT	2%
Mathematical sciences	8%
Physical science	16%
Waste and sanitation	2%
Web science	2%
No response	4%

5. Gender

6. Ethnicity

7. Participants with a disability
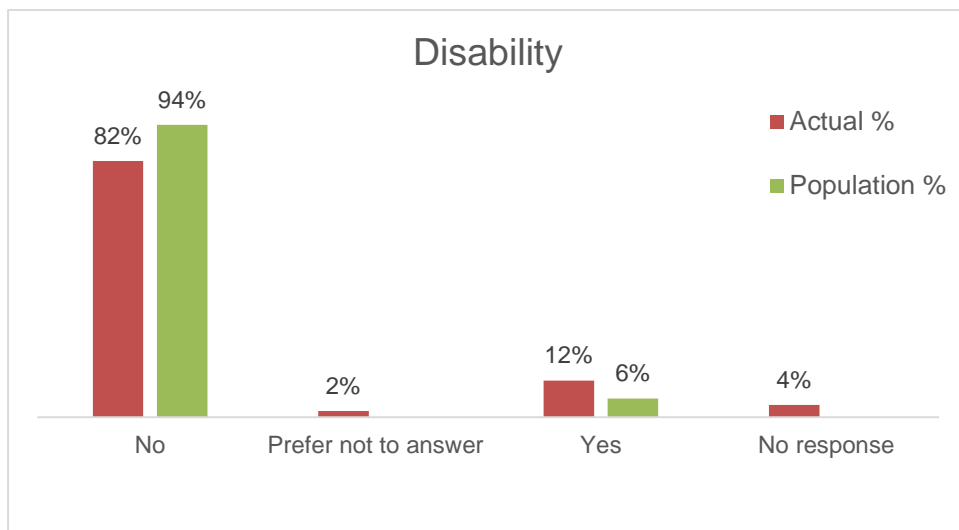
8. Age
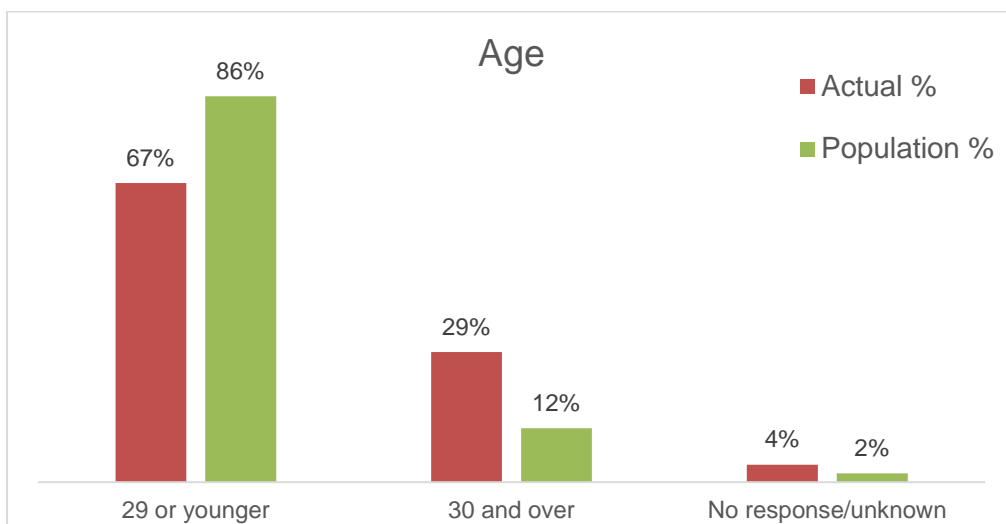
9. List of institutions

Institution	Participants
Bangor University	1
Cardiff University	1
Cranfield University	2
Loughborough University	3
Newcastle University	3
Queen Mary University of London	1
Queen's University Belfast	2
Swansea University	2
University College London	6
University of Bath	1
University of Bristol	4
University of Cambridge	1
University of Edinburgh	1
University of Huddersfield	1
University of Leicester	1
University of Lincoln	1
University of Liverpool	1
University of Nottingham	3
University of Oxford	3
University of Southampton	1
University of St Andrews	3
University of Strathclyde	1
University of Surrey	1
University of Warwick	3
University of York	1
Prefer not to answer/not listed	3
Total	**51**

Alumni focus group profile

One focus was held with previous EPSRC-funded doctoral researchers. Fourteen alumni were selected to reflect as wide a range of careers are possible. The profile of the nine alumni participants who attended the focus group is as follows.

Employing organisation
Arup
BAE Systems Marine
EirGrid
Liverpool John Moores University
McLaren Racing
Oxford Nanoimaging

Rolls-Royce
Swansea University
Self-employed consultant

Doctoral education
6 from CDTs
3 from EngD programmes
3 graduated in 2019, 2 in 2018, with one each from 2016, 2017 and 2020; and one undeclared.

Demographics
5 women and 4 men
3 identified as ethnic minorities
2 were 29 years old or younger, 5 between 30-39 years old, 2 were between 40-=49 years old

Appendix 3: Impact of Covid restrictions

Although exploring the specific impact of Covid was not one of the aims of the focus groups, the previous 15 months of Covid and associated restrictions had clearly impacted significantly on participants' experiences of their doctoral education. With a third of participants in the first year of their doctorate, the majority of whom had not had any access to their department since they had started, inevitably the impact of Covid generally was threaded through the discussions. Overwhelmingly, the mood was one of frustration and resignation to a situation that was outside their control. Participants appeared to have been impacted to different degrees, with some reporting having to completely change their projects, for example from a practical to a theoretical project. One participant described the cancellation of international fieldwork essential to set up their project. Participants reported that industry placements had been cancelled or in one example moved online.

> it's one thing that a lot of people talk about when you do PhDs is you get to travel to go to conferences, improve your public speaking and stuff like that. And that, of course, hasn't happened. In [Institution], we were one of the first to have lockdown and we've basically never left lockdown until this March. So, it was very difficult for our uni to provide these things other than the generalised Zoom courses

> Travelling, any of that is out the window, any of the interesting social stuff, pretty much out the window. But I mean, I guess I started during Covid, so my expectations were pretty low. So, I guess it's met my expectations in that sense. But compared to what I expected two years ago, way before I started, before Covid, it's definitely much worse. Hopefully, that will change.

> It's maybe not so much what I wished I could have done. But with my project, even though it's all been in Covid, I've still had loads of opportunities to collaborate with people and businesses and stuff. So, it's good.

> So, the university were very supportive. During the last lockdown, it was very difficult, because we are not living in a very big house, and I have three children, and they were here all the time. So, the only option for me was just go to the university and work there. And also, the university had foundation support for all PhD students who had to care for children. So, I was very happy with this.

Participants commonly reported the negative impact of Covid on their ability to interact with their research group or department, with first year participants highlighting their isolation. The restrictions had limited their ability to attend conferences, travel and build their networks, although there were a few examples of where having to move to online meetings had facilitated their international collaborations. One participant reported being able to attend more (online) conferences and undertake more training than expected due to Covid. One first year participant described their frustration of trying to navigate the health and safety requirements and training to be able to gain access to their laboratory for the first time, while another had felt conflicted about preventing others from accessing limited lab time.

> While we're allowed to go into workspaces, unfortunately, I wasn't really able to access the labs. Because the work that I do in the labs, there's limited time slots available, and we have a postdoc who is doing the same work. If I was in the labs, it's essentially a person that can't do their job. So, it was very difficult and frustrating. So essentially, I

know they give priority to PhDs, but if we're doing the exact same thing, what is the point of me being at a lab when someone's paid to do it? I did a lot of work remotely and only occasionally went in, if something specific came up. I've lost a lot in terms of [not getting] technical development through lab work.

Being unable to get to know their peers and other research group members was felt most keenly by first year participants, with individuals speaking about the isolation of working from home and of only having spoken to two or three people in the institution.

I've barely met any senior PhD students, and this is all due to Covid. I've heard that the previous batch of PhD students always had a mentor assigned to them. The mentor would be a senior PhD student who you could talk to or get guidance from in the kind of situations that have been mentioned previously. But in our batch, we haven't been assigned anything and we haven't had any interactions. I just know two other PhD students who sit in the same room as me. I barely know anyone else. And apart from them, I just know my flatmate, so it's not such a good situation,

There was also some concern about the process of returning to the institution post-Covid restrictions, with one participant concerned that individual needs were not being taken into account, particularly for those who had been shielding due to underlying medical conditions. Some doctoral students spoke about dealing with mental health issues during Covid.

A few commented on unexpected benefits of Covid forcing a change in approach or developing a new skillset, which in one case had led to an offer of a postdoctoral position.

When I started my PhD, I was fully experimental. And then, after some conversations in my second year, I became interested in doing more modelling and simulation work, which I was very fortunate to become sufficiently experienced in that before Covid took over. And that's led me now to accepting a post-doctoral position which is fully [simulation]. And I wouldn't be in that position I don't think if I didn't have a supervisor who was supportive of allowing students to take their time to develop their own interests.

One participant described how, as a distant doctoral student, Covid had increased their access to their doctoral programme.

I signed up for the PhD, aiming to do it as virtually as possible. So, I never intended to relocate; I was always going to be an occasional visitor to the uni. And had I had to go through the training modules and so on, as we were discussing before, doing all of that face to face, I'd have spent a lot of nights in the short-term hall of residence. Which would have been fine, that was what I was intending to do. But actually, what Covid has done is it's forced the university to offer almost everything on a virtual basis. And for me, that's great. So, I'm not saying that's everybody's situation or everybody's preference, but I do think it's worth remembering that the capacity to do things on a virtual basis does help at least some of the people. And potentially, there's an opportunity for the universities to provide more to a wider range of people. Perhaps people in different circumstances and so on. So, it's not all bad. I think there's been a useful new capability developed in the last year, by the necessity of Covid.

There was also mention of Covid extensions being welcome, but insufficient to cover the lost time and not accessible to all doctoral students who had been negatively impacted by the restrictions on their research. A few mentioned that the extension criteria were not clear and responses to requests opaque.