HOUSE OF LORDS

Science and Technology Committee

Corrected oral evidence: People and skills in UK STEM

Tuesday 25 October 2022

11.15 am

Watch the meeting

Members present: Lord Krebs (The Chair); Baroness Brown of Cambridge; Baroness Blackwood of North Oxford; Viscount Hanworth; Lord Holmes of Richmond; Baroness Manningham-Buller; Lord Mitchell; Lord Rees of Ludlow; Baroness Rock; Baroness Sheehan; Baroness Walmsley; Baroness Warwick of Undercliffe; Lord Wei; Lord Winston.

Evidence Session No. 8 Heard in Public Questions 55 - 61

Witnesses

Jenni French, Head of Teacher Supply Programmes, Gatsby Foundation; James Zuccollo, Director for School Workforce Research, Education Policy Institute; Professor Carole Mundell, President, Science Council.

USE OF THE TRANSCRIPT

This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Jenni French, James Zuccollo and Professor Carole Mundell.

The Chair: I would like to welcome the witnesses to the committee's sixth evidence session for its inquiry into people and skills in UK STEM. Our witnesses are Jenni French, head of teacher supply programmes at the Gatsby Foundation; Professor Carole Mundell, president of the Science Council; and James Zuccollo, director for school workforce research at the Education Policy Institute. Thank you very much for joining us. The session is being broadcast live on Parliament TV, and you will receive a full transcript, which will be made available to you shortly. You will then have an opportunity to make any minor corrections that you wish to add.

Q55 **Baroness Manningham-Buller:** We have heard in previous sessions of the difficult in recruiting and retaining some teachers in STEM subjects, particularly in physics, where the graph is extremely depressing and going downward. This is a long-standing and worsening problem. If you were in government and could do something about this, what would it be?

Professor Carole Mundell: I will give you my perspective both as the president of the Science Council, and as a physicist and a woman. I would like to contextualise the challenge in terms of the pressures on teachers generally across our schools sector and the disparities we see with resources.

Physics becomes the canary in the mine for the pressures that our teachers express, and because it is a shortage subject that is where the shortage appears to manifest. In some ways physics is not special. I hope that we will bring the details out in this session, but the advice I have had when speaking to my colleagues across the Royal Society of Biology, the Royal Society of Chemistry and the Institute of Physics—from whom I know you have had written submissions—is that over several years the Government have attempted to remedy this problem, but in fact something much more systemic is needed.

We have seen significant bursaries to attract physics graduates into physics teaching, but the wider career structure, career development and valuing of teachers in our education sector is the piece that is really lacking. With the operational issues in giving those bursaries, at the end of the bursary it turns into a real-terms salary cut for teachers.

Similarly, there is a growing lack of continuous professional development and support for those teachers. You can come in on a bursary and you may be a brilliant physicist, but it is a very different thing when you step into a classroom. Experienced teachers who have stayed in the field have noticed the decline in resource and support for those more experienced teachers to be able to support teachers entering the profession. I am sure Jenni will be able to comment more on this.

There is a career progression issue. It appears that the only way to really be promoted within the teaching profession is to go into management,

which takes you out of the classroom, again compounding the problem. Physics is particularly special because it is very sought after in many professions outside of teaching. If you can attract physicists into teaching with bursaries or with whatever means you use, at the end of those bursaries they are then very highly sought after in other professions. The Institute of Physics workforce skills project found that occupations with a distinct need for physics knowledge account for one in 20 jobs—1.85 million jobs—across the UK and Ireland, and there are many more jobs that value physics and science thinking.

Finally, because of the Government trying to use these stopgap measures to get graduates into physics and to do the retraining, it is now of concern to the Royal Society of Biology and the Royal Society of Chemistry, as biology-qualified graduates are now retraining to take up those bursaries in physics and chemistry. We are now starting to draw from biology, which previously had less of a problem. We are seeing unintended consequences from possible well-meaning but stopgap measures. I am happy to go into more detail, because I have more comments to make, but I will pass to my fellow panellists now I have set the scene.

Baroness Manningham-Buller: To sum up, it is a vicious circle of bits of initiatives that have backlashes.

Professor Carole Mundell: We have to look systemically across the profession. We need to value the professionalism of our teachers, and look at how we support them, reducing the administrative workload and the constant measurements. We need to value our teachers and trust them as professionals, and then start to put in that continuous professional development. Again, I can comment on specific measures.

Jenni French: I totally agree with everything my colleague said. If I was in government, there are two things I would do immediately that I think would have some impact. The first is around pay, because it is the only measure that government can immediately control in schools. We have evidence from working with the NFER that bursaries and starting salaries have an impact on recruitment. Of course, recruitment is not everything, and we want experienced teachers in our classrooms.

We have done some work with Sam Sims at UCL. His research showed that paying teachers a 5% salary supplement not only would have alleviated the shortage of teachers had we applied it between 2011 and 2015 but would have been cheaper than simply recruiting new teachers, even if it had been possible to recruit them in the first place.

Baroness Manningham-Buller: Is that 5% across the board?

Jenni French: It is 5% to shortage subject teachers. The research looked at work in the States and then modelled the data back on the teaching population in England. Since then, government has introduced a similar scheme and it did pay retention payments to teachers in shortage subjects in particular parts of the country. Evaluation of that scheme showed exactly the same elasticity; teachers were 23% less likely to leave if they were paid a salary supplement. There is a policy in place

now to do that in very small areas, but I would roll that out across the country because it would immediately help the solution. It is not going to solve everything. All the things that Carole has spoken about make a difference.

The second thing I would do is work with the community to define what we mean by a specialist teacher. At the moment the way we record a specialist teacher, if they are a teacher of physics, is that they have a physics degree or, in some cases, they have done their teacher training in physics. What that means is that, if they have done professional development, we are not able to count them as physics teachers.

What do we mean by a physics teacher? Do we mean someone who can teach A-level? Do we mean they can teach it up to GCSE? Do we mean that they are a competent teacher in lower secondary? Once we have that definition that the whole community agrees on, we can start to retrain people to the level that we need, through all these types of professional development. We then need a way of counting those teachers. As I mentioned, the school workforce census covers only degrees, so I would find a way of counting that professional development so we can not only incentivise teachers in the classroom to stay through professional development but retrain teachers to balance the workforce better across the sciences.

Baroness Manningham-Buller: If you incentivise them, is the provision of CPD available?

Jenni French: A lot of programmes have been available. The Institute of Physics, STEM Learning, the Ogden Trust and ASE all run programmes. There are government programmes. There certainly could be more, but there are good mechanisms in place.

Baroness Manningham-Buller: You have given us two things. Professor Mundell gave us at least half a dozen; I stopped counting. Do you have any to add, Mr Zuccollo, or to confirm?

James Zuccollo: I am going to agree entirely with Jenni. There are two parts to this. One is the overall picture, as people have said, that teacher retention is worsening over time. I do not think we know in an absolute sense what good or bad is across the industry, necessarily, but it has got worse over the last decade that we have been measuring. I do not think it is a coincidence that teachers' real pay has fallen by 5% to 10%—depending on how experienced you are—over that time, as salaries in the rest of the economy have also risen in comparable professions. Over the long term, it is clear why retention is falling in part.

There are then differences between subjects, between regions of the country, and between challenging schools and more affluent schools. More affluent schools find it easier to retain teachers in subjects such as physics. A graduate in physics, maybe five years after they graduate, is likely to earn £3,000 more outside teaching on average than they are inside teaching, which is not an inconsiderable sum. That is about 10% extra that they would earn outside.

These differences that have opened up over the past decade mean that we have a lot of biology teachers, because biologists tend not to earn so much outside teaching, but not a lot of physics graduates becoming teachers, because they tend to earn an awful lot more outside of teaching. Work on pay is the first place that I would look.

When you ask teachers, they do not mention pay so much. They mention workload. They mention how challenging the classroom has become, and the level of accountability in secondary schools. Those are very difficult problems that the Department for Education has worked extremely hard to tackle over the past three or four years with its recruitment and retention strategy. There were a lot of great initiatives in that strategy in some areas. The department has done a little less through the pandemic. It has understandably been distracted by other things. Returning to that and ensuring its implementation is crucial.

Q56 **Lord Wei:** We have received evidence that shortages are particularly acute in poorer areas, and that consequently students are prevented from taking triple science at GCSE and deterred from taking physics at A-level. How much evidence is there that current policies are perpetuating inequalities in UK education? We have heard about pay, but particularly in poorer areas are there other factors as well as pay that are making this more difficult?

Professor Carole Mundell: Yes, that disparity is there. That also then determines the choices of the students, of course, so you have a negative feedback loop in terms of the diversity, particularly in subjects such as physics. Anecdotally, private schools may also have more dedicated staff who support teachers, for example technical staff and administrative staff, so they are able to add more enrichment activities such as placements and reaching out to industry, whereas in the more deprived schools it is the teachers themselves who have to take on those extra duties, which further adds to their workload.

Although it is difficult to attract teachers into those more deprived areas, particularly those with degree subject specialities, there may be practical ways in the short term to support those schools with those additional ancillary posts. Those technical posts also, for example, help make experimental labs function well, which is another disparity in the experimental sciences. Students are not able to have that experiential learning that the students in more affluent schools do, and that affects their confidence and ability to choose those subjects for further education.

Jenni French: I agree. There are actually very few schools that do not offer triple science at GCSE. We do not really know a lot about the data, but we do know that it is likely that schools in poorer areas are not entering as many students into triple science as perhaps they might like to, had they more teachers.

Interestingly, we have done some research looking at advertisements for teachers. We found that schools that are in challenging circumstances—however you want to define that—are significantly less likely to advertise

for specialist teachers, so even if you were a physics teacher who felt that you would like to teach in such a school, it would be quite difficult to do that because they are not asking for you. It is a circle that perpetuates, because you are more likely to apply to an independent school or a school that is asking for a physics specialist if you want to teach physics.

Lord Wei: Do we know why that is?

Jenni French: We do not know why. I suspect it started because they felt they would not be able to attract a physics specialist, but we need to break that cycle somehow. If schools want a physics specialist, we need to get them to ask for a physics specialist. There is no evidence that they are more likely to readvertise if they ask for a physics specialist, interestingly. Part of the problem may be trying to shift schools into asking for what they would actually like.

James Zuccollo: I agree with Jenni. It may be that they have struggled to recruit. At the Education Policy Institute we tried to measure what proportion of teachers in different subjects, including physics, have a degree in their subjects in disadvantaged schools and in more affluent schools. On average, across subjects, you are looking at about two-thirds to three-quarters of teachers who have an undergraduate degree in the subject they teach. For physics, about half of teachers in affluent schools have a relevant degree, but if you look at disadvantaged schools it is only about 16% who have a relevant degree in physics. It is very, very low.

Do we know how exactly this is causally related to differences in what people study? Unfortunately we do not. It is very difficult to measure, as Jenni said. It is really hard to unpick the causality here, but it seems very likely at the least that those schools are struggling to recruit the teachers they would like to recruit, presuming that, like other schools in more affluent areas, they would like to recruit someone who has a degree in the area. That probably carries across all the sciences and all the other subjects that they are recruiting to as well. They are struggling to get the teachers they really want.

Lord Wei: To follow up on that, in an ideal world we would love to have physics degree graduates teaching physics, but we are having to make do. What is the correlation between having that degree and the performance? Are we seeing outliers where they do not have that degree but the output in terms of the achievement or the progression in physics is really good? To enhance that, if poorer areas are finding it hard to recruit certain types of teachers, such as physics teachers, is there an option to do hybrid or bring in people remotely or part time from industry? Does any of that work?

James Zuccollo: It is really hard to say. The evidence is very mixed, and it is hard to unpick the causality. Do people with a degree in their subject actually make better teachers of that subject? Intuitively you would think, yes, if they know something about it, of course they are going to be better at it. In the data it is much harder to see that. It may well be that finding other ways to provide the knowledge—Jenni talked about the subject knowledge enhancement courses—if you had a very good

teacher, could give you equivalent outcomes, but it is hard to know at the moment.

Jenni French: I agree. It is hard to understand. We have some evidence that subject knowledge enhancement courses work but we do not know who has subject knowledge enhancement courses, so we cannot measure that in the data. We can measure only degrees. All of this about subject knowledge is a proxy for degree, and that is not the whole picture. We need a better way of understanding what is happening about that. I believe they can work, and it is the only solution, really, because we just do not have enough physics graduates to fill all the vacancies. That is the reality.

In terms of a hybrid model, relationships matter. If we want people to progress into physics, into engineering or into becoming technicians, as we have just heard about, the relationship with the teacher matters. I would be very wary of replacing that experience with another form of teaching. Real people form those relationships.

Professor Carole Mundell: It is clear that when a physics graduate actively chooses to go into teaching they are doing so because they are incredibly passionate about their subject. They have the subject matter expertise that is deeper than the curriculum itself, which adds value.

In terms of mitigating this problem, there is some suggestion that schools are reluctant to accept part-time teachers. As Jenni said, this is a challenge in a daily operational model for a school, but it may help increase flexibility if that could gradually be developed over time, because you would then be able to have people who work in industry, with slightly higher salaries, acting as teachers part time. That would help the ecosystem.

Finally, for physics in particular, I would just be radical and say you are mostly missing 50% of your population. We still have a very male-dominated field, so there is a whole untapped section there. It is not just teaching that is short of physics graduates; it is the whole of industry and technology. That pull-through is growing with those technology fields, so the shortage gap is actually increasing. We do need that positive feedback. Once you get those inspiring teachers in school, they are then enabling a very diverse group of young people to think about physics as a route to a whole varied set of careers.

Again, that goes to the earlier session and the challenge of helping schools understand the breadth and depth of careers. Ironically, biology and chemistry appear to have better representation in terms of understanding of career paths at school than physics, but physics is the one that seems to have the big pull-through to industry and, therefore, the shortage for teaching.

Q57 **Baroness Sheehan:** I would like to refocus on the challenge of retention. We are aware that a significant fraction of teachers leave the profession within the first five years, and perhaps as many as half in the shortage subjects. What are the major causes of this inability to retain teachers, and what can be done about it?

James Zuccollo: We have already touched on the difficulties of pay and the DfE's recruitment and retention press, so I will say something about a couple of other things in addition to those, which I still think are the most important issues for retention, particularly pay.

When we think about workload, there is increasing evidence that the type of workload matters enormously to teachers. They are doing marking and administration that they do not see as contributing to the education of students. That really reduces their job satisfaction. There has been an increase in this kind of workload over the past decade as accountability measures have increased their pressure on teachers. There is something here about how to improve the quality of management and leadership within schools, which I know is a part of the Department for Education's recruitment and retention strategy. There are new national professional qualifications for all sorts of leadership within schools to try to address that. I am hopeful that in the medium to long term that will make a difference.

Baroness Sheehan: I should have said that my son benefited from a bursary and is now a physics teacher, which is great. One of the reasons he took physics—he is an engineering graduate and then decided to teach physics and maths—is that there is much less marking involved. Just to pick up on that question on workload, can you just comment on that? Is there much less of a workload in subjects such as physics and maths?

James Zuccollo: I am not aware of that data on average, actually. To be honest, our longitudinal data on workload is a little shaky. In aggregate we have a rough idea of how many hours teachers work, but the data on exactly what they do each week is quite small scale. It is not broken down between subjects, so I would not want to say that on average there is less in one subject than another. I am not sure, but maybe I should look again at that.

Baroness Sheehan: That is very interesting, because a lot of the comments on why we lose teachers seem to be subjective. Is there hard data that we can look at and point to anywhere in pedagoguery?

Jenni French: There are interpretations; there is no hard data. James has just described the situation of the data quite well. It is quite hard to unpick by subject. Just to pick up your point on workload, I agree with James's point, but there is a difference in the sciences because of the expectation to teach outside your subject.

Your son may be very lucky and is in a school where he is teaching predominantly physics, or physics and maths, which match very well together. Physics, chemistry and biology may not match quite so well together, because as a physicist you may not have taken biology post GCSE, so trying to teach another subject could add to your workload.

Picking up on the earlier point about schools in more deprived areas perhaps not having specialist teachers, that is a contributing factor. If you are routinely expected to teach outside your specialism, it may be more likely that you leave the classroom, because the workload becomes unmanageable.

Baroness Sheehan: Professor Mundell, can we talk a little bit about what we can do about retention, and maybe about CPD?

Professor Carole Mundell: Building on colleagues' comments, we can change the lens on valuing specialist teachers. At the moment there seems little incentive to build a strong career as a specialist physics teacher or a specialist chemistry teacher, so we need to bring that value back.

There are two things that can help there. Pay progression needs to be looked at, not just starting salary but pay throughout the career. What is valued there? As Jenni said, being a good colleague is teaching outside of your field. We can change that lens to say, "Being a good colleague is developing yourself through CPD and then helping develop other specialist teachers, either within your school or your region or beyond".

For the CPD side, we have evidence that says that one in 12 physics teachers who did not participate in STEM learning CPD left teaching the following year, compared with one in 30 who did. It is very clear that CPD helps retention and is part of that wider systemic change. It shows the potential for CPD to be a positive force. In fact, the Royal Society has also noted that subject-specific CPD provision in England compares unfavourably with other high-performing countries. We have potential to increase that CPD provision.

From the perspective of the Science Council, we hold the registration for the chartered scientist teacher qualification. That is a useful, pragmatic tool for valuing teachers' quality. Incentivising schools to support their teachers to go for that qualification through their CPD may be a way to make that CPD very visible. That is something that government can do, through Ofsted, to encourage and support schools to help their teachers follow that.

The Chair: On what you have just said about CPD, how do you know the cause and effect arrow is not the other way around, in that teachers who are more committed to continuing are more likely to undertake CPD?

Professor Carole Mundell: We do not know yet, but we know that where it is provided and teachers take it on they are more likely to stay. We know that the provision is low in the UK compared to other countries, so it is a win-win to provide it and to encourage teachers to take it. Again, it is something we can ask teachers, but there is also that lens of how the school and the school system values that CPD. We do not want this to be another hoop that we force teachers to jump through. It should be something that is really seen as part of their long-term career development and how they are then valued within their profession.

Baroness Sheehan: Is CPD available to all teachers in shortage subjects?

Professor Carole Mundell: I do not believe it is, but we can find some more details for you after the session from the learned professional societies, if that would be helpful.

Jenni French: The Government have recently rolled out the early career framework, which is a programme for all teachers in the early part of their careers. It is still in its very early stages and I hope that will eventually help improve retention, but interestingly a survey that we did recently with Teacher Tapp showed that just 2% of the mentors and 4% of the teachers who are taking part in the programme felt it was subject specific enough. That is not just in the sciences; that is in all subjects. There is a strong call from teachers that CPD that is provided needs to be more subject specific.

Q58 **Baroness Warwick of Undercliffe:** We have actually spent rather a long time on the question I was going to ask, which is about the way in which pay affects both recruitment and retention. Let us just focus on recruitment to see whether it is the key issue that we can at least make some sort of recommendation on. Everybody seems to say that it is one of the most difficult and significant areas in attracting graduates into the profession, particularly physics. You all talked about the different attempts to alleviate that. I wonder how we can go further on that and whether, at the same time, we need to focus, as all of you have said, on the uplift of all teachers across the profession. It is the whole profession that is now in low repute, if one can put it that way. Could you address both those, so that we can at least see whether there are ways in which specialist teachers might be attracted by a differential in pay?

Professor Carole Mundell: I appreciate that all organisations are resource-limited. We have evidence that the bursaries have worked for specialist teachers to attract teachers in. I would reinforce my point about teacher retention, because if you do not address that you are constantly stuck in the loop of asking, "How do we attract more teachers?" Retention is very important, and that will then add value to those programmes that actually succeed in attracting teachers. We need a systemic approach.

As I have said, pay progression is important—if you come in on a bursary for five years, then what? If you feel a real-terms cut in your salary, it is not helpful. On top of that is the support for teachers coming in. You come in with a bursary, but do you feel supported in the classroom to develop those skills? Again, that can feed back in to the career development of more experienced teachers. If you value the work they do through their career and pay progression in the mentoring that they do for their junior colleagues, that may help address the issue Jenni has commented on about the lack of subject-specific CPD, because if you lose those teachers after five years they are not there to support on CPD. I quite strongly believe it is a systemic approach. We have had these ad hoc, quick emergency approaches, which we now need to start bedding into the system.

James Zuccollo: It is always difficult to know what to do when there is a limited budget. It is clear that, if there were more money in teachers' pay, there would be more people wanting to become teachers. What you are asking is whether we could reshuffle some of that money in some way in order to have more specialist teachers. There are a couple of obvious ways.

One is more differentiation between the pay of teachers who teach different subjects. Biology and history graduates get paid far more in teaching, on average, than they do outside teaching, but physics and chemistry graduates get paid much less in teaching than they do outside teaching. That is reflected in the retention rates for those teachers. At the beginning of careers and recruitment, there are large bursaries, but it is open to people to then immediately leave when they get this real-terms pay cut.

Before the pandemic, the Department for Education changed these bursaries to be delivered in the third and fifth year after graduation as well, if one was still in the profession. That was hugely successful, but it was dropped during the pandemic and is gradually coming back as levelling-up payments and so on now.

One could certainly see that some of the bursary moneys that are paid during training at the moment could be paid later to increase retention. That has worked extremely well in the United States in several places, and can be tuned to give teachers an incentive to stay in more disadvantaged or challenging schools, which is something that the Department for Education is also evaluating or rolling out in pilot and has been very successful overseas.

Baroness Warwick of Undercliffe: Are you convinced that the argument has been successfully made to the Department that it is simply lack of resources that is preventing a more dynamic approach to this?

James Zuccollo: Departmental analysts and officials I have spoken to are convinced by this, although of course there are budget constraints on them. One of the big questions for me is why schools have not gone further in this direction on their own, because all academies have the freedom to pay teachers any way they like. They are not required to pay teachers the same, and yet we have not seen much differentiation across subjects. To me, that is still a little bit of a mystery.

Jenni French: James has described the situation well. The evidence is compelling that pay has an impact. Bursaries are not the whole solution, because of the enormous target we have for physics teachers and the relatively small number of graduates we have. We can keep upping the bursary, but that is not going to solve the problem on its own. As my colleagues have said, retention really matters, and we can use pay as a lever for retention.

Baroness Warwick of Undercliffe: Is there any other particular specific incentive you would recommend or suggest that might have proved successful?

Jenni French: In terms of pay, I would go back to my original opening point. Had we paid shortage subject teachers a 5% salary supplement, we would not be in quite the same situation that we are now. I am encouraged, as is James, that officials understand that and that this is now being piloted. I would roll it out more quickly, but in the long run it is cheaper than simply recruiting new teachers, because it costs a lot of money to train a teacher and to pay a bursary. Not only does paying

teachers in the classroom represent good value for money; it also gives the young people more experienced teachers rather than simply churning over and giving them newly qualified teachers in a cycle.

Q59 **Lord Rees of Ludlow:** I would like to ask about another approach to the shortage, which is to get people to join the teaching profession in middle age after another career. I wonder whether you have any views on this. One imagines there are lots of well-qualified people who have been in industry, the Army or other places who could, with a small amount of training, become really excellent, committed teachers in middle age.

James Zuccollo: It is an excellent idea. The Government tried this with former military staff. I do not think it was hugely successful. There is an organisation called NowTeach that tries to recruit people when they have had another career. I have not looked in the last few months, but they have several hundred recruits each year. The department needs to recruit some 30,000 or 40,000 new teachers every year, so that has not had a huge impact yet.

The pay cut from being mid-career to becoming an entry-level teacher on, soon, £30,000 would be quite large for a lot of successful professionals who have a degree or a graduate degree. That is going to limit the impact it has on those career changes.

Lord Rees of Ludlow: Some may be prepared to take a pay cut if they are in their 50s.

James Zuccollo: Let us hope so.

Jenni French: I agree. We have tried this with those in the military and it was not hugely successful. We also know from talking to teacher trainers that career changers tend to drop out of programmes at greater rates than graduates, so there probably needs to be some additional support in terms of thinking about what it is that career changers might need.

I am incredibly supportive of the idea of broadening the number of people going into teaching. Specifically, courses have just come around for engineers going into physics teaching, whether they are career changers or graduate engineers. Tailoring the courses so that it is not a one-size-fits-all is a good way forward.

Lord Rees of Ludlow: Before I ask Carole to comment on this question, I would like to bring up a second question especially for her. There is an overall shortage of physics undergraduates. I wonder to what extent this shortage, which is important not just for the lack of teachers but in other professions, would be alleviated if we changed to something like a baccalaureate system. What could happen now is that young people who are turned off science at 16 will then drop it and will not be qualified for admission to a good undergraduate course in physics. I wonder whether there is a linkage between the 16-to-18 curriculum, for those who are aiming at universities, and the problems we are addressing in this session.

Professor Carole Mundell: That is a deep question. Let me try to address it. In terms of your original question about bringing people in from different professions in middle age, I support James and Jenni's comments on salary. I would also go back to one of my earlier comments on enrichment activities. I know that there are retired physicists and engineers. The British Science Association does some wonderful seminars online, so we have some really passionate scientists who are now in their retirement years.

I have been engaged with affluent schools that will call me and say, "Would you come in and give a seminar or would you do something on Zoom?" so they have the confidence to reach out. They also have the administrative and technical support, and the ancillary staff who will help arrange those visits. There could be resource allocated and we could look systemically, particularly at schools that lack subject matter specialist teachers or where those teachers are very strained, to see whether we could regionally support them with those enrichment activities. To actually have somebody retrain as a teacher and go through all their DBS checking is much more involved than having a support visit. I know the Ogden Trust and the Nuffield Foundation support these programmes, so they are possibly a good vehicle for that.

On the wider provision of A-levels, there is much debate about what prevents students taking physics. Again, I have looked at this particularly on the gender side. You meet young girls who are very keen on physics up to the age of 12, and then you start to lose them much earlier than 16 to 18. There has been much debate about whether experiment is needed—whether they need a physics A-level to study physics at university or whether maths would be an appropriate entry. There is still an open debate about that. I am very happy to have that discussion with you offline and take it back to our learned societies.

What is necessary for you to study physics at university? How do you continue to enjoy physics as a subject? Often those young women are choosing medicine. They will do chemistry, biology and maybe maths; they will drop physics. Alternatively, they will be going into psychology or business because, for whatever reason—maybe they are in a very male-dominated class in a mixed comprehensive school—they lack role models and they will say, "Physics is not for me. Even though I love the subject, it's clearly not something girls and women do".

We have had a long-standing systemic problem about role models. Again, as I said earlier on to Lord Wei, we are missing 50% of our population in the physical sciences and engineering. It is a big challenge, and I know organisations like the Institute of Physics continue to work very hard to try to move the dial there.

Finally, we have that positive feedback loop. If we have more physics graduates, we have much more opportunity to draw on those graduates for a whole range of professions, be it the technical professions, industry, business or teaching.

Lord Rees of Ludlow: Those gender-dependent choices of subject have to be made at 16, in effect, do they not?

Professor Carole Mundell: Anecdotally, from my personal experience of speaking to teenage girls and watching them in mixed environments—it is very different in single-sex schools—and speaking to the young women who have come on to my physics courses in Bath, there is a subtle bias already.

Let me mention Dr Jess Wade at Imperial College London. She has been stalwartly editing the Wikipedia pages of some 1,700 physicists and engineers who are women or from ethnic-minority backgrounds. She is an absolute force of nature. She has managed to move the dial from something like 17% to 19% of Wikipedia pages because she really believes we are not celebrating the full talent in the profession and therefore young people are not seeing that this is a career choice for them.

Lord Rees of Ludlow: James or Jenni, do you have any thoughts on this question, particularly the breadth of the 16-to-18 curriculum?

Jenni French: I agree with Carole. Young women and girls make choices much earlier than 16. We need to be working through all through school. The Institute of Physics has done a lot of work, trying to work with the whole school, rather than just the physics or science department. That is where you seem to have some impact in moving the dial.

Q60 **Baroness Rock:** This inquiry has also been exploring policy around skills and lifelong learning. We have heard about deficits in secondary school teachers for STEM subjects. Are there similar deficits in people who can deliver the skills training and adult education in these subjects? If there are, what can be done to address that?

Jenni French: If you think of a subject in schools, it is probably worse in terms of further education, skills and adult training. That just about sums it up. The issues are the same. The pay in further education is lower than it is in schools, and the disparity between being in a profession and teaching in FE is greater.

The data is significantly worse than it is in schools, so being able to understand what is happening is tough. It is also really important that we give access to higher-quality initial teacher education for those who are teaching.

Baroness Rock: Again, we come back to a lack of data in a lot of this.

Jenni French: That is exactly right.

Baroness Rock: James, do you have anything to add to that? What could be done to address it and what progress are the Government making on delivering additional technical education?

James Zuccollo: Unfortunately I have very little to add because of the problem Jenni mentioned. The data is so limited on adult education. There is limited data on the further education workforce, but once you get outside further education to adult retraining almost nothing is available. It is very hard to know how much progress is being made.

I know the Department for Education is rolling out a new census of the workforce in further education to try to take steps to remedy that. In contrast to mainstream primary and secondary education, when you look at further education or, in the other direction, early years, there is a dearth of information on what is going on. It is very hard to understand why it is not working as we had hoped, unfortunately.

Baroness Rock: A lot of what we are hearing is very anecdotal, really.

James Zuccollo: A lot of it is based on small-scale surveys. We do not know for sure whether they represent the entire population. That also means that breaking that down into specific subjects or regions, as you can do with mainstream education, becomes very difficult.

Professor Carole Mundell: The Science Council has been supporting learned societies on the technical pathways. We hold the registers for registered scientists, chartered scientists, registered science technicians and chartered science teachers. We have been working hard for five years on the technical pathways and supporting career progression for technicians in academia, further education, public sector labs and private labs.

That has been hard work, but it has been really positive. Those technicians are our lifeblood. They are the engine of our innovation, but they are quite hidden and unvalued. Their career progression has been a great exemplar from which we can probably take some valuable lessons.

Most recently, Research England, which is one of the arm's-length bodies of UKRI, funded a pilot project called the Herschel Programme for Women in Technical Leadership. The very first cohort has just graduated. It was incredible to see those women, who were very accomplished, work on their leadership and management skills. Although their technical skills were already very high, they lacked the confidence, as many leading women do in science and technology.

Baroness Rock: How big would that cohort be?

Professor Carole Mundell: I am trying to think. I can get you the exact numbers. They had originally thought there might be 40 or 50 applicants and they got some 180 for the very first call. They are now on their second call, so they are hoping to continue to have that funded.

Those sorts of programmes show that there is a huge appetite for this continuous professional development, as well as recognition for it. To go for your registration or charter status, we have a huge network of volunteers who do the peer review. They are subject matter specialists. There is a mentorship programme that supports you.

I am going through my chartered scientist qualification now, which is not something that is very well recognised in academia because we go with our PhD and our postdoctoral research. I am going through it as a senior academic and thinking about the impact my science has beyond my field. It is a really interesting process.

Q61 **Viscount Hanworth:** Is there much we can learn by considering how

other countries organise their teaching? Are there any lessons we can learn by looking back at our own past arrangements? In particular, looking abroad, do we see some countries paying differential rates for teachers in the various subjects?

Professor Carole Mundell: I will defer to my colleagues on that, but I am happy to comment on continuous professional development, if I may.

The Royal Society recently noted that CPD provision in England compares unfavourably with other high-performing science nations. We can certainly get that data for you, but throughout teachers' careers continuous professional development support is lower in England than in other science nations.

Jenni French: Certainly, research has been done on pay in different areas of the States. Where they have paid teachers more and paid a salary supplement, that has been shown to have the same impact and improved rate of retention as the pilot work in the UK. We are reasonably confident that it is a factor that can apply in other parts of the world as well.

James Zuccollo: Jenni is exactly right about that. In the United States there is the advantage that there are all sorts of different states and districts that run their own small education systems. There is the opportunity to run comparative statistics between them. As Jenni said, we have learned a huge amount about the deferred bursary payments and their impact on retention, and about the use of pay to encourage teachers to work in and stay in disadvantage schools.

There are other systems around the world, such as that in Shanghai, which performs extremely well. Teachers have to move through a disadvantaged school to achieve status within the profession. Improving an already well performing school or keeping it at that level is not seen to be as high status as turning around a school that has been performing poorly. We could learn from some of those routes, as well as the culture and career paths that Carole talked about.

In many of those systems, they are also much more directive about where teachers go than we are in England. We allow a fairly open market in teaching, where schools employ the teachers rather than the state, a district or a federal Government.

It is hard to import things directly. When you look at these differences, you want to know how much impact these things are having on the attainment of the pupils. It is hard to say that these small differences in the employment of teachers are having a great impact on the overall skills of the pupils in the country, but we see that countries that have effective education systems, where very skilled, literate and numerate people are coming out of university and school, end up having very skilled, literate and numerate teachers, who then do a better job of teaching their students in a virtuous circle.

When we look at Japan, Singapore or South Korea, which have extremely high educational attainment, it is also the case that their teachers score extremely well on standard numeracy, literacy and other cognitive skill

tests relative to teachers in England or western Europe. That may well explain large parts of it, so I do not know how much I would want to attribute the performance of their system to these small differences in employment and pay.

Viscount Hanworth: Are we seeing any divergences between the salary scales in academies and schools under local authorities? If so, do we draw any inferences from that?

James Zuccollo: We see surprisingly little. There has been research on this. It shows that, although the attainment of students has improved slightly in areas where you have seen more divergence of salary scales, it is fair to say that divergence has happened far less than people expected when academies took freedoms.

The other point I was going to make was about the pupil premium that is given for students who get free school meals. There is extra money that schools with a larger proportion of free school meals students get. It was expected that schools would use that, particularly academies, to pay more for teachers and attract teachers to these more challenging schools. That has happened far less than we imagined it would.

Viscount Hanworth: Jenni, do we see any great resentment in the teaching profession of the idea of differential rates? Is there a growing acceptance of that notion?

Jenni French: We do hear that from senior leadership teams in schools. They are reluctant to introduce differential pay. That is the reason, as James has hinted at, that we do not see as much differential pay as we would expect. It is why the government schemes in terms of delayed bursaries or salary top-ups work better. They take it out of the hands of the school.

Viscount Hanworth: It does not have this invidious aspect to it.

Jenni French: Yes, exactly.

Lord Wei: I have a couple of follow-up questions for you. First, for a lot of the data we have collected, it seems like we are not always quite clear on the causality. Is there a reason for that? Should there be more research into some of these questions to work out which way the causality is working?

Secondly, is there a role for regulatory bodies such as Ofsted? You might be familiar with the work of Professor Hattie, who argues that performance generally in education is correlated to the quality of the relationship between the teacher and the pupil, the quality of the feedback and how hard the work is.

In STEM in particular, has there been any work looking at how the people who study these subjects and the backgrounds they come from affect that equation—the relationship between the teacher and the pupil? There may be more of a sink-or-swim culture: "You're going to be good. You're going to have to study".

There are two questions really. One is about causality. The other is about

how we incentivise this focus on the quality of the relationship and the teaching side rather than all the other things we do.

James Zuccollo: I can briefly address the first one; I will leave the more complicated one.

Professor Carole Mundell: I will take the second one.

James Zuccollo: Unpicking causality is always very difficult in social sciences. Huge strides have been made in statistical techniques over the last 30 years to be able to do this. In the end, you would quite like to have a comparison between two very similar groups who got different sorts of education. As we have a fairly national education system in England, that typically does not happen. That is why, as Jenni said, a lot of the evidence comes from the United States, where it is far more fragmented or diverse—pick your preferred word.

Lord Wei: The homogeneity of the system is a problem.

Jenni French: It is also quite hard to unpick what happens within an individual school. We do not know, for example, whether schools give specialist teachers to their top sets because they want to push them on to A-level or to the children they want to get above a 4 or 5 grade to push them over the GCSE pass mark. We do not have the data and we do not collect the data routinely to match which teachers are teaching which classes. With all James's points, even taking that example, we just cannot tell who is teaching what and what impact that is having on the system.

Professor Carole Mundell: There are two aspects here. There is the joy of discovery and creating a scientifically literate population and the kind of teaching you need in order to pass the exams. They are two axes that are related. We have a wonderful science museum culture in the UK; we have a wonderful public engagement culture. People can watch wonderful programmes on TV. Some members of the committee here have been involved in those sorts of outreach programmes. While that axis is related to and underpins attainment in exams, if we focus just on the measurement, that can sometimes squeeze the joy out of learning the subject and exploring it.

One of the real challenges we have in physics is the perception, because it is always seen as a white male-dominated field and the lone genius scientist trope persists, that physics is an abnormally difficult subject. There is social science research that shows that children as young as six, both boys and girls, identify with the mistaken stereotype that boys are naturally clever and girls have to work hard.

When you put those two lenses together, you immediately get that assumption that girls will not be able to do physics because it is really hard and they will have to work harder. All that is false, in my opinion. These are the kinds of social stereotypes, that get fed in early on and are just absorbed from society, which schools then have to battle.

For parents, teachers and the pupils themselves, we need to open up that joy of discovery at an early stage, keep it going through with the quality

of the teaching, and then turn that into success at the exam stage. All that is integrated through the satisfaction that teachers get in their own continuous professional development and by refreshing their joy and their understanding of their subject. Ofsted has an opportunity to encourage that rather than just think about the measurement metrics, where, as we say, the cause and effect are hard to unpick.

Lord Wei: Should we be starting to teach things such as physics earlier? When you get to choosing GCSEs and A-levels, it all becomes very ruthless. Both the pupil and the community around the pupil are having to say, "What are we going to drop? For the hard ones, we can't get the A and progress".

Jenni French: There is an argument for ensuring that we have specialist teachers in the early part of secondary school, so they can inspire a love for the subject.

Building on what Carole was saying, when we are training physicists, we have this idea that we are training them to do a physics degree or maybe to go into engineering. We have forgotten perhaps what was discussed in the last session about the amount of physics that is required in a whole variety of technical skills. We need to get the message across that you do not have to be getting 9s at GCSE to continue studying physics in some way.

In fact, next week we will be opening a permanent gallery at the Science Museum called "Technicians", celebrating the work of technicians in science, engineering and technology. It is a very careers-focused gallery aimed at 11 to 16 year-olds. We would be very keen to work with any of you who would like to come along to the launch, or we could arrange a tour for you to see some of the ways we could encourage young people to think about physics or other sciences not just at a graduate level.

Professor Carole Mundell: One of the comments I have heard teachers make about that earlier stage before GCSE is that they are seeing constant churn in the curriculum at GCSE level, but, when it comes to the provision for the younger years, they are already thinking ahead with five-year strategies as to what skills students will have to develop in order to address those exams. If they are seeing constant churn at the exam level and the curriculum level, they are not able to feed that back quickly enough to early years. Stability is one of the strong messages that I am hearing from teachers.

Lord Winston: You do a brilliant job at Bath, and we should be very grateful. I just wondered whether you feel that informal teaching, going out into schools and doing outreach, should be more rewarded by universities. It is not always recognised.

Professor Carole Mundell: It is a really good question. The people who do it are very passionate about it. For a very long time, research fellowships, for example, have had a percentage dedicated to public engagement. My personal experience is that scientists and academic scientists really believe that is a core part of their job. They love their subject and they want to communicate it. Not all scientists feel

comfortable communicating it. That is why it is helpful in universities. We have a public engagement unit at the University of Bath, which helps our scientists engage in different ways. Some people will go into the local shopping centre and do a session on a Saturday. Others will go on TV.

There is something about upskilling our scientists and helping them communicate the work they do in a way that is accessible to the public. In my work in the Foreign Office, the UK was very highly regarded for the quality of its science communication. That has put us in a good place when it comes to times of crisis such as the pandemic. We have a deep science communication culture. We have the Science Media Centre and particular institutions that support our scientists.

It depends on the university as to whether that is valued and recognised as part of career progression. Research is one of the main things we are rewarded for as academics, but we are also very mindful of the impact our research has. Public communication and engagement is part of that impact matrix.

The Chair: Thank you very much. We have now reached the end of our time. I thank all three witnesses for a very interesting session. Thank you for your time and thank you for the evidence you have given us.

As I mentioned at the beginning, you will be sent the transcript very shortly and you will have a chance to add any editorial comments, if you wish. If there is any further evidence that you would like to send us in writing, we would also be very happy to receive that. For now, I am going to close this session. Thank you very much indeed.