

Education for 11-16 Year Olds Committee

Corrected oral evidence: Education for 11-16 year olds

Thursday 27 April 2023

11.20 am

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Members present: Lord Johnson of Marylebone (The Chair); Lord Aberdare; Lord Baker of Dorking; Baroness Blower; Baroness Evans of Bowes Park; Baroness Garden of Frognal; Lord Knight of Weymouth; Lord Mair; Lord Storey; Lord Watson of Invergowrie

Evidence Session No. 3

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Questions 27 - 40

Witnesses

I: Julia Adamson, Managing Director, Education & Public Benefit, British Computer Society; Dr Hilary Leever, CEO, EngineeringUK; Charles Tracy OBE, Senior Adviser for Learning & Skills, Institute of Physics.

Examination of witnesses

Julia Adamson, Charles Tracy and Dr Hilary Leever

Q27 **The Chair:** Good morning and welcome to this evidence session on education for 11 to 16 year-olds. I thank our witnesses for joining us today. As usual, a transcript of the meeting will be sent to you. You will have the opportunity to make corrections to it where necessary, and it will be published on the committee's website.

Perhaps we could have a very quick introduction from each of you, saying who you are and what you do in your organisation. Then I will hand over to the members of the committee, who are keen to get cracking.

Dr Hilary Leever: I am the CEO of EngineeringUK. We are a charitable organisation supported by professional engineers and their institutions and by corporate members from across engineering and technology. Our focus is on making sure that the UK has the engineering and technology

workforce it needs for those sectors to thrive in their own right and to improve sustainability and meet net zero.

Julia Adamson: I am the managing director for education and public benefit at the British Computer Society. Our focus is on people, skills and capability, looking at the whole of the digital society and economy and not just tech organisations; every organisation is a digital one. We know that everyone engages with the world through digital tools and there is rapid change in this area.

Charles Tracy: I am at the Institute of Physics. I was head of education there for 14 years and I am now the senior adviser for learning and skills. The institute, as you might imagine, has an interest in physics but also in ensuring that everyone has a high-quality experience of physics at school and in improving diversity and access to physics at that level.

Lord Knight of Weymouth: Before we start, may I say for the record in this public session that I am doing a bit of unpaid work for EngineeringUK in co-chairing an inquiry into apprenticeships?

The Chair: Terrific. Thank you.

Q28 **Lord Aberdare:** Good morning. Welcome, and thank you for joining us. My question is about curriculum and qualifications. Do the 11-to-16 curriculum and qualifications available in this phase sufficiently value your subject and effectively balance knowledge acquisition and practical application? Of particular importance is the second bit of the question: getting the right balance between knowledge and skills, essentially.

Dr Hilary Leever: Engineering is not particularly visible in the 11-to-16 curriculum. There is a GCSE, which has a very low uptake, and a vocational qualification, but most of the people who progress into engineering come through other subject choices. D&T is probably the subject that is most associated with engineering and has a huge amount of overlap and engineering content in it. You could say, based on its very significant decline in recent years, that it is not sufficiently valued.

Some data has just been shared with us on that. D&T is now taken by 78,000 students. Uptake has halved over the last decade, for reasons that might be associated with a lack of value. It is not in the EBacc, which is all about what the most valuable subjects are. The academies and free schools that can deviate from the national curriculum do so and there is a lower uptake of design and technology in those schools.

There are also some very quantitative demonstrations of value. Despite a huge teaching shortage and recruitment issues, D&T has had a late introduction of the teaching training bursary and it is lower than that for other sciences and high-stakes subjects. Also, the extent to which schools can offer it depends on how much value they give it, and it is very expensive, so schools have to value it very highly to prioritise the provision of classrooms, materials and all the special equipment that it requires. There is an issue about valuing D&T.

We also have routes into engineering through more academic subjects. I will let Julia speak to computer science. Software engineers are engineers, and digital skills are inherent in most engineers' work day to day, so it is a really important precursor subject for us, as are maths, physics and the other sciences. I will let Charles speak to physics, but if you look at how the sciences are taught in schools, it is very much about knowledge and less about the career contextualisation that would follow, which for many is engineering.

The knock-on effect is that the visibility of engineering as an outcome and a career pathway is low, and we know that it is lower for young people than for their knowledge of science and technology careers. The lack of curriculum presence means that it is hard for schools that are doing their best to conform to the Gatsby benchmarks and the curriculum links in benchmark 4, for example, to see them as being important for engineering. The lack of visibility has a genuine impact.

Pre 16, we know—it is quite clear—that vocational qualifications are not valued in the same way as academic qualifications are. It intrigues me, now that we looking for post-16 parity of esteem—and the introduction of T-levels is a great way of trying to raise the esteem in which the main technical pathway is held—we are getting very different messaging before students hit the 16 year-old decision point. It is worth thinking through the repercussions of that and what could be done to improve it, and to make sure that young people have a taste of that more contextualised learning so that, should they transition into the more technical/vocational pathways, the transition is easier for them. I know that was a long answer, but there is so much here.

Julia Adamson: In computing, there are three distinct communities that we need to focus on the needs of.

There are specialist computer scientists, who will go on to be the producers of future products and services. First, we need a plentiful and diverse pipeline of young people going on through that route. Secondly, we also need higher-level technical users to understand the capabilities of those tools and services and to use them in their jobs, in their industries—from pharmaceuticals to farming to food production to transport. The final group is for every citizen to have the digital skills to be able to engage and participate fully in the digital society, where the stakes are high. Getting a bank loan, filling out a benefits claim form and so on all require digital skills.

At the moment, we are confusing the needs of the three groups, and we need to stand back and address their needs as a whole. We are only addressing the specialist group. We have a computer science GCSE, not a computing one. It is the only national curriculum subject that does not have a matching GCSE. It is good news that we have a national curriculum subject in computing and computer science as an EBacc subject, so we may benefit from some of the things that Hilary said engineering does not have. However, very few young people choose the computer science GCSE—only 13% of the cohort—and a significantly low

proportion of girls choose it, so it is not necessarily working and we do not have a solution for all the needs at the moment.

The BCS landscape review report that we published in March 2022 highlighted the tension between teaching computer science as a specialism and digital skills for all. This is felt right across the UK and there are different approaches to addressing it. Wales, for example, with its extensive curriculum qualifications reform, has a statutory right to develop digital competence alongside literacy and numeracy, as well as two parallel GCSE options, one for digital technology and one for computer science.

To your point about the balance between knowledge and skills, qualifications drive the curriculum, of course, and the curriculum, even lower down than key stage 4, is driven by what students will have available to them as qualifications. In my opinion, we are overemphasising knowledge at the expense of assessing what you can do with that knowledge, and that impacts on young people's experiences of computing in the curriculum.

Charles Tracy: It is a very interesting question, and it is a good time to be thinking about the balance between different types of knowledge in the curriculum.

The current curriculum in the sciences and in physics is definitely content-rich, and not just content-rich but built on content. Most people think it is probably overloaded with content, sometimes called *substantive* knowledge. It can leave the impression that physics is a large compendium of disparate facts.

We would prefer to think of physics as a set of ways of thinking, which have given rise to some of the most powerful and influential explanations that affect the modern world. Those ways of thinking include practical work and the procedural knowledge of conducting investigations and practicals, but it goes beyond that. It is the practices and ways of thinking of physics that follow up that work that are important: how to analyse data, how to use models in explanations, how to use mathematics and relationships to predict behaviours, how to use IT, coding and computing.

As such, we have been working with teachers, academics and researchers, and other scientific professional bodies to develop guidance for a curriculum that explicitly outlines that disciplinary knowledge and those practices and ways of thinking in the sciences, and does so in a way that builds towards a smaller number of big ideas rather than a large number of small facts.

The curriculum would still include content—of course, you have to have content (substantive knowledge)—but that content would be chosen by how well it illustrates the big ideas or the practices and ways of thinking in physics. It would be chosen more carefully, it would build towards big ideas, and it would get away from the idea that physics and other exams

are just about recalling a lot of low-level facts. To be clear, we are not advocating a skills-based curriculum. It would be strong on domain knowledge. All the evidence shows that the most innovative and creative people in a domain have strong domain knowledge but can also think and behave in a disciplinary way.

So we, along with the other professional bodies, would like to see a curriculum that develops a deep understanding of the discipline and the big ideas of physics and the other sciences, built on a smaller number of big ideas and explicitly including the practices and ways of thinking. We think that would prepare people to be the innovators of the future.

Q29 Lord Aberdare: I will ask one of my several hundred follow-up questions and focus on Hilary Leever and engineering.

We hear a lot about the shortage of engineers coming out of the system. Also, I know some young engineers who seem to be the wrong sort and cannot find the jobs for which they are qualified. From what you were saying, it sounds to me as if the problem goes back further than the secondary level; it goes back to the level we are focusing on, the 11-to-16 year-olds. Could you say something about how you would tackle some of those problems you describe, such as the lack of people being attracted to the subject at that earlier stage?

Dr Hilary Leever: We would say that the issues start in primary and go the whole way through. A lot of them are cultural, particularly when it comes to the perceptions of who will become an engineer but also what engineering is. There are some very outdated perceptions of engineering that do not recognise the contemporary face and breadth of engineering—in particular, its key role in meeting sustainability and climate change challenges.

You referenced workforce needs. The estimates of workforce needs are mind-boggling and very concerning: 300,000 roles by 2030 to address climate change and get us on the pathway to net zero, across a huge breadth of sectors, from energy to transport to construction, and a huge breadth of levels, as well as areas of engineering and technology.

How can we address that? We need more relatable role models and greater visibility on who may become an engineer. We need young people to understand what engineering is. It is often referred to as science or D&T, and often in parliamentary circles as innovation. Indeed, there is a new department with “Innovation” in its name, between “Science” and “Technology”. That tends to be engineering rather than innovation, so engineering is not spoken about very accurately, which is a quite critical issue.

We also need to make sure that the quality of careers advice in this area is strong. We know that careers advice is very patchy across the country, and it is clearly ineffective. In our annual survey, the Engineering Brand Monitor, which looks at young people’s understanding of what different people do, engineers rank lower than scientists and people working in technology, and the young people who understand what engineers do are

twice as likely to want to become one. To my earlier point, if they understand the link between engineering and sustainability, they are seven times more likely to be interested in a career in engineering. So a lot of it is about information sharing, but it is also about having clearer pathways through, and a greater connection between what might be studied from an academic, theoretical and factual basis and engineering outcomes.

Q30 Lord Knight of Weymouth: I have had some interesting correspondence recently from a guy called Conrad Wolfram, the founder of Wolfram Alpha, the technology behind Siri and other software engineering. He argues that our maths curriculum needs to change to become more computational in its thinking and to have more real-world application.

My sense, listening to the three of you, is that you have a very consistent message, but there is a question in my mind. What if we were to be more radical and build on what Charles was saying about the big ideas of physics? There are some big ideas across the whole of STEM. Does having individual voices from individual subjects mean that you become too wedded to your subjects rather than think about the curriculum of STEM as a whole, linking maths, physics, data, computing and the application of theoretical knowledge? Could they be brought together more holistically in the experience of learning in secondary school?

Charles Tracy: Yes, I think so, particularly in primary. One of our concerns about primary is that some of the expectations that children have about their future are set in primary school—from society, from the schools themselves. Girls, for example, and other groups do not think of their future being in physics. We would certainly like to see a holistic approach to diversity in primary school, and we have campaigned on that.

On the specifics of the curriculum, we think that the best preparation for physics in secondary school is things other than physics in primary school. It is about having experiences: experiencing the phenomena of the world, making things, feeling things. Building stuff, basically, that is technology. A science and technology curriculum at primary school would be interesting to explore. We do not have a worked-up view of it, but we are working towards one.

Julia Adamson: I completely agree. Computing is, by its nature, making, using, modifying, playing with things, and it is incredibly difficult if it is just theoretical. To have that context through other STEM subjects, where you realise and understand the purpose and the meaning, would also have an impact on the gender balance. One of the things we are hearing from girls is that the context is missing and it does not feel relevant to them. It does not feel relevant to their lived experiences of technology in their lives outside the classroom, and that could be improved by a more holistic view of STEM and digital.

Dr Hilary Leever: It depends on the outcome that you are trying to achieve. At EngineeringUK we are very much workforce focused. The subjects may be represented by subject associations, but in their hearts they have an interest in how their subject is manifested in society. We tend to think of subjects in education having a more discrete outcome. It comes down to the much larger question about the purpose of education and whether it is about people having a high-quality educational experience. I know you are also looking at other outcomes relating to mental health and preparedness for future jobs, for example, but there are national needs: what outcome do we need from the education system as a nation? That has to be to respond to workforce needs, and in which case you start taking a more holistic and combined approach.

I know that is how we and my colleagues here work. We talk to each a lot and we support each other in trying to achieve connectedness.

The Chair: Thank you.

- Q31 **Lord Mair:** Following on from Lord Knight's point about the holistic approach, is there a problem almost with the nomenclature in the perception of children, particularly young girls—that engineering somehow conjures up the wrong kind of image? Design and technology has been in decline. There are all sorts of reasons for that, but would it be beneficial to emphasise at a very early stage that engineering is simply applied science; it is simply the application of all the things we have been talking about—physics, computer science, mathematics and indeed chemistry and other science subjects?

Starting with Hilary Leever, because you represent engineering, do you feel that there is a possible problem with separating engineering from all the other applications of science?

Dr Hilary Leever: That is an interesting question. We are trying to reclaim the word "engineering". We have worked with the Royal Academy of Engineering and the sector as a whole on a range of promotions. This is Engineering, for example, is a fantastic campaign, and I encourage you to look at it. We are making progress. We are seeing slow increases in the numbers of people coming into engineering and in the diversity of people coming into engineering, including gender, socioeconomic status, ethnic backgrounds and disabilities. So it is not that we are making no progress.

I would be inclined to stick with the word "engineering", because otherwise we would have to rebrand the profession as a whole, but I would have it being used much more frequently in many more contexts, and accurately; the number of times I hear someone say, "Meet this amazing scientist", when the person is not a scientist but an engineer.

Lord Mair: Yes. I was in no sense saying that we should abandon the word "engineering". I wanted to make the point that because of the way we portray engineering to children it is seen somehow as a separate subject from science, which it is not.

Dr Hilary Leever: We need that connectedness, absolutely.

Q32 **Lord Watson of Invergowrie:** I am finding what all three witnesses are saying very interesting. I just want to pick up on one point that all three have mentioned, the question of diversity, which basically means more girls taking engineering and science subjects. I know that the Institute of Physics has been pursuing a campaign on whole-school equity plans, which are aimed at broadening the diversity base, which is not just girls but also people from ethnic minorities. How might we broaden the base of young people across the board going into the subjects that we are talking about this morning?

Julia Adamson: Computing is like glitter. It is really exciting. It is shiny and we want to get our hands on it. It is in everything—transport, culture, fun, every sector, every occupation—and in places you would not expect. It is difficult to get rid of, so the glitter analogy is a great one. We need to equip young people with the knowledge and critical skills to be able to thrive in the digital world, and they need to enjoy it. It needs to be exciting and fun, and they need to feel that they are good at it. At the moment, the grading is quite harsh, we feel, and we have taken that up with the regulator.

Young people need to see themselves there—as Hilary Leever said, role models are important—and they need a range of routes to be open for as long as possible. We must not close them down and narrow the curriculum too early so that young people have to make decisions when they are still not sure, and we must not make computing and engineering separate so that young people have to choose one thing over another. We need to let young people follow the things they are good at and are interested in while gaining a clear understanding of how those things are going to change the world and make it a better place. We need to let them see that they can have a role in that.

Charles Tracy: It is something that we worry about a lot, of course. To put it in context, about 23% of A-level students are girls. If you are in the highest quintile socioeconomically, you are three times more likely to take physics than if you are in the lowest quintile. Only 2% of black and Caribbean students take physics A-level compared with 5% of the general population. The lack of diversity is a problem for innovation in the future and for those young people.

Our research and evidence have shown the problem comes largely from the messaging young people get at a whole-school level. Lord Watson mentioned the whole-school equity plans. Messaging can come from outside the physics classroom. Those groups are essentially told, or get the message, that they are not suitable for physics or physics is not for them. We have pretty horrific evidence of that from lived stories and our own research—for instance, a teacher calling girls in a class “team Fake Tan”. Once we were watching a class, and every time a girl put her hand up the boys mumbled, “Get back in the kitchen”.

These things are quite shocking and are not necessarily about physics but about a whole-school approach to equity. We need anyone who influences children not to limit their horizons by putting expectations on them based on their socioeconomic background, gender or ethnicity. That is why we have a campaign to stop those limitations, the Limit Less campaign, which we are running at the moment to encourage whole-school equity plans, and we ask and expect that all teachers are trained in a whole-school approach to inclusion.

Q33 Lord Baker of Dorking: I want to talk about assessment and qualifications in your various subjects. I will start with computing, if I may.

In the blue bars on the first chart, you will see that GCSE computer science has dropped away dramatically in the last five to 10 years. Far fewer people in 11-to-16 year-old schools are taking the exam at the end of their period that makes them qualified in data skills. Only 13% of students at school today take GCSE computer science. So let us deal with this exam, because if you do not do that, you will not get people taking it. Are you familiar with the curriculum of that exam, by any chance? It is basically about coding, which in a few years will be done entirely by artificial intelligence. It is very turgid and uninteresting. In the assessment, in the exams for computing—I do not know if you know this—are they asking questions about virtual reality, helmets on your head? Would you know that? I do not expect that you do, do you? I am not trying to say that you are ignorant.

Julia Adamson: First, I do not recognise the trend shown on the chart, so it would be useful to follow up on that, which I can do after this meeting. The numbers of young people taking the GCSE in the single qualification that exists now—there is no other; there is no IT GCSE, for example—are low. As you said, they are around 12% to 13%, and a significant proportion—nine in 10, or more—of those are not girls. The qualification is focused on the theoretical knowledge required in computer science. It does not represent the subject of computing, as you have quite rightly pointed out.

You mentioned coding. To some extent, ChatGPT and other generative AI will make that more accessible to people, but it will not mean that we do not need anybody to know about coding. We need to know how stuff works, otherwise it kind of appears as magic.

Let us improve the current GCSE in computer science so that it is as good as it can be as a specialist route for young people who wish to choose it. Let us have a qualification that recognises those higher-level technical skills so that people can use and apply the technology.

Lord Baker of Dorking: I understand that. I am asking you about the technical skills. You are having to admit that in the assessment of technical skills, there is no assessment of virtual reality, cybersecurity or CAD/CAM.

Julia Adamson: Not in the specification for GCSE.

Lord Baker of Dorking: But without CAD/CAM you cannot design anything in engineering. You cannot use the 3D printer. What I am trying to establish is that none of these things are in the assessment system of GCSE computer science. It is just theory, theory, theory. There is no assessment of how to run a network, is there?

Julia Adamson: I agree that major improvements are needed.

Lord Baker of Dorking: You agree with all of this, but how many of the last 10 Education Secretaries have you spoken to and said that you want all those things covered, not just theory?

Julia Adamson: BCS regularly communicates with the computing policy team at DfE and regularly meets with the Minister for Schools to raise these issues.

Lord Baker of Dorking: But you have failed, I am afraid. Do you know, for example, that 79,000 students took GCSE computer science this last year and 139,000 took Spanish? The figures in these charts are all government figures, by the way. There is a total mismatch between what your industry needs and what schools are producing.

Julia Adamson: Absolutely.

Lord Baker of Dorking: I really do think you should be making more of it. Coming to engineering, I am afraid it is not a very much better picture, as you know. You have said all the right things. You want to promote engineering—yes, we do—but the figures here are quite distressing. There is another chart here.

Lord Knight of Weymouth: Can we steer a bit more towards assessment methods?

The Chair: Lord Baker, we are seeking to have the witnesses say whether the current GCSEs are an appropriate way of assessing knowledge and skills.

Lord Baker of Dorking: Exactly so. That is what I am trying to show: that GCSE computer science does not do that, and there should be another qualification that is much more practically based.

When it comes to engineering, it is very much the same story, as you will know. You all know the figures. Roughly 23% of schools offer engineering, but only 4% of 16 year-olds take on engineering, which means that there are very few A-levels in engineering each year. We all deplore that, but here again there is a mismatch between what the schools are offering and what you want. How many Secretaries of State have you spoken to in the last 10 years and bullied them a bit? I know bullying is not fashionable.

The Chair: Let us have an answer from the witnesses, because we need to move on.

Dr Hilary Leever: This comes back to my earlier point about the orientation of the 11-to-16 curriculum across all our subjects and the extent to which they are very much focused on an academic outcome rather than progressing people into employment in the sectors of need. That is about the purpose of education as a whole and of 11-to-16 education, which is a massive question for people like the Secretary of State. It is very hard for us to influence Secretaries of State as much as we would wish.

On the question of assessment, for engineering and D&T qualifications, there is a balance and there continues to be some course assessment of the more practical skills. In the sciences—also very important subjects for us, as I have said—there has been a move away from teacher assessment of practical skills, which you may be aware of. There was a decline in the number of practical skills in classrooms between 2016 and 2019 as those changes ran through the system, as found in the Science Education Tracker, even though young people identify practical work as very motivating for scientific study and many say that they want to do more.

Practical work has been severely retracted because of school lockdowns, and we are already seeing impacts of that. People who work in competitions—we have a Big Bang competition, and we talk with many other organisations that have competitions that are dependent on practical work by young people—have seen a significant decline in that work. This is another very serious issue about how to give young people opportunities for skills development.

Lord Baker of Dorking: Trying to summarise what you are saying, I think I am right in saying that, at 16, assessment is only practical in engineering BTECs. You have to show what you have been doing.

Dr Hilary Leever: And in D&T, that is correct, yes.

Lord Baker of Dorking: You have to show that you can use tools and materials. There is no question about that. It is exactly the same in A-levels in engineering. So you have got it all right, but you are simply not sucking enough people into it, are you? Somehow you have to make it more attractive and easier for young people to do it. As you will probably know, the curriculum is very crowded. You are not included at all in any of the basic subjects. How stridently do you say that the national curriculum is not appropriate to the needs of your industry—in those very words?

Dr Hilary Leever: We do not use those very words, but we do work across the community and through the National Engineering Policy Centre to try to bring that voice to government.

Charles Tracy: The sciences are an excellent route to engineering and to academic engineering degrees. About 15,000 people go from A-level physics to academic engineering degrees every year. Therefore, our main concern is what happens in the sciences up to 16. The biggest concern in

that phase is the inequitable access to high-quality teaching, partly based on there being two pathways.

At the moment, there is a triple-science pathway and a double-science pathway. One of them is more advantageous, because it tends to get specialist teachers, it tends to be taught separately and it has separate grades. However, the double-science pathway has plenty of space in the curriculum and we think that is the right size for a qualification, but it is usually taught by a mixture of teachers. You are more likely to get a non-specialist teacher in the combined science pathway than the triple science one, and you do not get separate grades. So the Combined Science pathway provides a less high-quality experience for its students. There is an equity issue there, because those students tend to be in schools in the more deprived areas.

Along with the other professional bodies, we strongly advocate for a single route through the sciences at GCSE, called "The Sciences", where they are taught separately, have a subject-specialist teacher and get a separate grade. In other words, it has the features of triple science but fits into a single route.

The Chair: Thank you. We need to move on because we need to cover a couple of other core subjects. This takes us nicely on to teacher recruitment and retention, which Lord Storey will ask about.

Q34 **Lord Storey:** Yes. My question is about the challenges facing teacher recruitment and retention, not generally but in your particular specialisms, and perhaps about the quality of the training of those teachers, so it is a twofold question. What problems do you face and what solutions might you offer up, and what about the training? Quite a big agenda.

Charles Tracy: Under-recruitment in physics is an enormous problem and has been for probably 30 years. There are about 30,000 science teachers in England, yet only 6,500 of them would be classed as physics specialists. You would hope that it was 10,000, but it is 6,500. We think there are about 400 schools without a physics specialist teaching in them. It is difficult to recruit and has always been so. Last year was a low, but we have had some highs.

Lord Storey: Does that go back to Lord Baker's point that if there are 400 schools without qualified physics teachers, that creates the problems that he highlighted?

Charles Tracy: It contributes to them, absolutely. Students who do not have a specialist teacher are less likely to progress to physics beyond 16. We are working with the DfE on recruitment. It sees this as a priority, and there are programmes in place to recruit engineers into teaching, because traditionally they do not come from university straight to teaching. Recruitment is a tough nut to crack. What we think is worth looking at more at this stage is retention. About 40% of physics teachers—slightly higher than the average—leave within five years.

Lord Storey: Do you know the reasons for that?

Charles Tracy: It is slight speculation at the moment, but we are doing some work to investigate that. One of the reasons is exactly the same as the one I talked about before: that they are expected to teach the other subjects. This relates to your question about training. You have a physics graduate who is gold dust and you train them to teach chemistry and biology, which are not their subjects, because they are going to be expected to teach them. Then you deploy them to teach chemistry and biology in schools, often because of the way the timetable is structured rather than for the benefit of students. Some schools clearly deploy physics, chemistry and biology specialists to teach all of physics, chemistry and biology.

Lord Storey: That gold dust would probably be more attracted to the private sector, because they get paid more there.

Charles Tracy: There is that as well, but that is not just in physics. That is also in computing and engineering.

Lord Storey: What is the solution? Is it to pay engineering, physics and computing teachers more to keep them? How do we do it?

Julia Adamson: As you can imagine, the demand for individuals with computer science is high outside teaching. There are so many opportunities for those individuals to earn lots of money elsewhere, so this challenge will never go away. That is the first thing that we need to recognise. We need to completely rethink teacher recruitment. Schools are finding the recruitment of computer science teachers extremely challenging right now, and there are some innovative solutions. There are, for example, more specialists spending time—a braided career—in education, donating time and expertise outside their work life. In east London, within two academic years they took attainment of the GCSE group from 46% A to C to 100% A to C at GCSE computer science.

You can think about recruitment on its own—I will not talk in more detail about this now—and about innovative solutions at scale, such as centralised specialised provision like the provision we offered during the pandemic. Organisations like Oak National Academy and Barefoot trialled and were successful at some of that. ITT (Initial Teacher Training) recruitment in computer science, just like physics, continues to be a massive issue. Last year, we reached only 30% of the target and this year looks to be about the same.

There are interventions. We already work with the DfE on interventions like scholarships. We have introduced 800 specialists into schools. I lack the data to know how many of them stay, how long they stay and whether they end up in mainstream state-funded schools. At best, we have one computer science teacher in each secondary school, and we know that fewer than 80% of schools offer computer science as a GCSE subject, so distribution is not fair across all schools. Also, that person is likely to be a non-specialist. There are very few subject specialists, which

impacts on teachers' ability to take their knowledge and turn it into something vibrant and realistic in the classroom.

The number of teachers with expertise in computing overall has stayed pretty static, with a number retraining from ICT to computer science. The Government's investment in the National Centre for Computing Education has been a good thing and is a good start, but it is only the start of the journey towards subject specialism.

- Q35 **Lord Knight of Weymouth:** The evidence we received largely discusses the extrinsic motivation behind recruitment and retention and pay. Pay is important, but can we do more on the intrinsic motivation and vocation in teaching? The Times Education Commission talked about consultant teacher career paths. Is that a solution? Where could we go on intrinsic motivation?

Dr Hilary Leever: There are some things to say about pay, but another issue with retention is CPD. Work done by the Education Datalab looked at the impact of STEM CPD. It was delivered by the National STEM Learning Centre so that they could have a coherent dataset to look at. Having taken STEM Learning Centre CPD increased the odds of a science teacher continuing to be in the workforce a year later by 160%, and that is after taking other factors like age and gender into account.

So we have a solid thing there, something that can really help with retention. Many of the other issues that we are talking about—teaching quality, student experience and teachers having to teach off their specialism—are also addressed by CPD. On diversity, some research suggests that girls and young women are more sensitive to the quality of teaching, which might be contributing to some of the gender disparity in their ongoing interest in areas like physics.

Building on Julia's point, we need to be innovative and creative and treat this very seriously. It needs to be addressed through funded research and more centralised trials. The Education Endowment Foundation did a round of research looking at how to increase STEM teacher retention, but it was completely disrupted by the pandemic, and as far as I am aware it has not picked up.

Thinking about different approaches to recruitment and retention—there are some—I would like to see the Engineers Teach Physics programme, extended with an Engineers Teach Computer Science programme and the Engineers Teach Maths programme rolled out. But we need innovation and real commitment to treat this with the seriousness that it needs.

- Q36 **Lord Baker of Dorking:** I have a very brief question about physics. You told us something very interesting, which was totally new news for me: that lots of physics teachers leave because they are being asked to teach chemistry and biology and they do not want to do that. There is one possible solution to that. Where you have a group of three schools, the teacher is not attached to any one but is attached to them all, going from one to the second to the third teaching physics, and does not pollute his

mind with chemistry or biology. Is that a possibility? Have you tried it? Is that not the way to do it?

Charles Tracy: It is one possibility, but the main thing is to ensure that deployment in the school is not driven by timetabling needs so that physics teachers are deployed to teach biology and chemistry. Some biology and chemistry teachers have to teach physics because there is a shortage of physics teachers.

There is another potential solution, which is a proper retraining programme. At the moment, biology and chemistry teachers are asked to teach physics with very limited training; it might literally be three days on their initial teacher training course. The way to deal with that is to have an in-service retraining course in physics or a pre-ITE subject knowledge enhancement course, a 24-week programme, that seriously brings teachers up to speed. Then they would be more comfortable and more likely to stay.

We do not have to go far to find a jurisdiction that has much better retention, and that is Scotland. In Scotland, the equivalent figure is 20% leaving after five years as opposed to 40% leaving in England. There is a big drop in the first year. That is always the case with any new career; people find that it is not for them. But after the first year, 1% or 2% per year are leaving in Scotland whereas it is 8% in England. One difference in Scotland is that they teach to their specialist subjects and it is timetabled as a specialist subject.

The Chair: Very interesting.

Julia Adamson: I want to add the connection between teachers teaching knowledge and skills that they value and the young people they are teaching value too. We cannot underestimate getting the qualifications right that drive a curriculum that is right. Those teachers feel that they are adding value. The young people leaving school this year will be working at the end of the 21st century and the beginning of the 22nd century.

Going back to the point about whether we are doing this right in computing, whether we have the right curriculum, whether we have the right qualifications, the answer is frankly no, not yet. We do not have that solution right. We are not equipping those young people for the future digital world that we live in. If we get that right, that will also help with teacher recruitment and retention.

The Chair: We now move the conversation to technology.

Q37 **Lord Knight of Weymouth:** We are interested in the future opportunity for both teaching and assessment. Some of the technology can redefine what is possible. We are interested in what that could look like in your subjects. You might want to touch on whether there are technologies, such as the large language model AIs, that are making some aspects of the current experience obsolete.

Julia Adamson: Digital technology is shaping everything and the accelerated change has never been more present than with the recent advances in generative AI. We have the opportunity in schools to take advantage of that to make teachers' lives easier, better, more efficient, more effective. Think about a digital assistant or a co-pilot that can enable you to be more productive. Think about adaptive technologies that can screen young people, and reading tools that can help to personalise their experience. Think about continuous assessment, so that the high-stakes single point of assessment at the end of their five-secondary career is removed because technology can monitor and adapt. There is so much opportunity.

Does it remove some of the elements for the subject? It probably increases it all. For me, it underpins yet again that computing is something that every child needs to experience. We need a route for the specialists, and we need to ensure that we equip enough young people and a diverse group to be the future designers, developers and creators of those products and services so that they meet the needs of the whole of society. We need higher-level technical skills for those young people, who are going to enter the workforce and work in every sector. We need to ensure that digital fluency is embedded throughout the curriculum for everyone, for their benefit, their place in society and their future life chances.

Lord Knight of Weymouth: Specifically on ChatGPT, which I know you have already made some comment on—and other similar AIs are available—I have spoken to people recently who are using that technology to create items for testing to ask the questions. I have been speaking to other people who are using AI to mark the answers to the questions. The prospect of AI marking its own homework is very real. Where do you think teachers should be focused on how to use that technology to help them best?

Julia Adamson: We asked our computing teachers about ChatGPT and whether they were ready for it. They felt very unprepared. They do not want it to be banned; they want it to be embraced and they want to understand more about it. With any of these tools—take a calculator—you have to have the foundational understanding to be able to utilise them, and it is the same with generative AI tools. They can progress and advance you, and you can get things done more quickly. Take teaching coding. I did my daughter's year 8 project in about 40 seconds using AI, but could she do that? Could she check whether it worked or not? That is the thing. We can reframe what we do with young people. We can use AI to deepen our knowledge and understanding.

The Chair: Can I build on Lord Knight's question and ask whether you agree with Martha Lane Fox, the UK's former digital champion, who said recently that the course correction towards more coding had been misplaced precisely because, as she put it, "the machines are going to do the coding". Do you agree with the former UK digital champion?

Julia Adamson: More machines will do more of the coding, but you will still need people with the knowledge and understanding of that coding and whether it is ethical. No new coding will happen, because these tools, these large-language models, look only at what has already been produced, so there would be no more advancement without coding.

Lord Knight of Weymouth: Charles, is the technology redefining what big ideas are important to stimulate young people in physics?

Charles Tracy: That is a very interesting question. It may well be. Certainly we need students to leave school with a sense that the sciences and engineering can contribute to answering the big ideas and the big questions through technology, so they have that awareness.

You asked specifically about technologies earlier. We are trialling a system of spaced learning, which essentially speeds up the presentation of a subject, leaves a space, tests children, and they come back to it. It can be done online, so you can get through a topic quickly. However, they then need the teacher to mediate that, to talk about any difficulties they have with understanding it, and so on. It can take advantage of the technology. We are trialling that at the moment and the results will be out soon. That relates a little to Julia's point about coding: that although systems can produce the code, you still need a person to know whether that code is valid.

Q38 **Lord Knight of Weymouth:** If I may, a very quick question for Hilary. Does the immediate access to the knowledge and the concepts that are embedded in these technologies change the balance between what we need to learn in respect of knowledge and what we need to be able to do in respect of the application of that knowledge? Do you see it redefining that tension that has been there throughout this session: that we have an obsessive focus on content knowledge as opposed to its application?

Dr Hilary Leever: I think we have all said that you need a depth of knowledge to build your ability to easily access everything else. You still need the knowledge to develop the thinking skills that enable you to utilise the more accessible knowledge.

However, I would like to reflect on the big changes since the thinking occurred for what is currently taught at 11 to 16: the huge technological advancements, which have been incredibly rapid recently; the focus on the need to respond to climate change—to adapt towards it and to mitigate against it; and the much greater appetite for genuine inclusion with a deeper understanding of how the content of what might be taught will limit inclusion and diversity of choice. If you looked at everything that is currently taught that was conceived 10 years ago, thinking of those three new developments, it would need review.

The Chair: Thank you.

Q39 **Lord Watson of Invergowrie:** I would like to pick up a point that Julia raised about ChatGPT. Certainly she is right that it is here to stay. It is not going to be disinvented.

On the question of assessment in schools, I wonder what Julia and the other witnesses might think about the uses I have heard suggested: that where ChatGPT is used, pupils will be asked to explain why they have submitted a particular answer. That would be done in effect through oral testing. Leave aside for a moment the logistics of that and how many teachers you would need to do that with every pupil, would it not contribute to a young person's confidence if oral testing was part of the assessment? I am a member of the all-party group on oracy, and this week a university professor told us that her students are unable even to contribute effectively in tutorials with their peers in their chosen subjects because they have not developed those skills. I wonder if that could be a spin-off from the benefit of using oral as part of assessment beside ChatGPT submissions.

Julia Adamson: I completely agree. It is so important, with any technology, that you are choosing the right tool, you know why you are choosing it and you know what the potential is. Then you know whether the tool has done the thing that you wanted it to do in the first place, and you can say that. There is lots of potential for that.

Q40 Lord Baker of Dorking: This question is directed at Hilary and takes up what Lord Knight was saying.

Is there a technology that you could somehow think of that should be in every school? My question is directed to you, because you are the person in the room who knows how important 3D printers are in industry. They are dominating everything. They are used for body parts. In Accrington, they are building 43 houses with 3D printers. Houses can be built in three days. America, Guatemala and New Mexico are doing the same. A 3D printer has now invented a rocket that can go into the stratosphere and is built entirely by a 3D printer—no human hands.

One of my campaigns is to get a 3D printer into every school. They only cost £200. You can teach the students very quickly how to use them by teaching them computer-assisted design. In the colleges that I sponsor—UTCs—we have hundreds of 3D printers. This is something that you can give to a student that is technical and practical and which they can understand very quickly. They have to use their minds, design a thing on a computer, then get the 3D printer to create whatever they want to do. They will create something that cannot be made by a human hand. What are you doing to get to that nirvana?

Dr Hilary Leivers: We do not have that as a specific campaign. It would be a wonderful thing to have, but it is not one of our specific desires for technology in every school. The most important thing to be doing and to be thinking about in the context of how the digital world can enable young people is access. We saw inequality of access during the pandemic. It was somewhat addressed at the time, but as we are all moving to more embedded technology, ensuring that there is good equality of access for all students is critical. That has fallen off the agenda, but schools have continued to use technology after having had to do that large uplift. So that would be my main priority. However, thank you so much for the engineering-focused question.

The Chair: Unless either of our other two panellists wants to come in—I do not think they do—we will bring this public session to a close. I thank our witnesses very much for their time and their stimulating contributions.