All-Party Parliamentary Group for Education

Chair – Danny Kinahan MP

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STEM Roundtable Transcript (verbatim)

Participants:

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Dr Mhairi Crawford, WISE Campaign
Steve Emery, Instruments Direct
Fiona Miller, BT
Tim Oates, Cambridge Assessment
David Perks, East London Science School
Richard Picking, Gratnells
Chris Ratcliffe, Scholastic
Anne-Marie Shand, Pearson
Julie Swan, Ofqual
Martina Ratto, MyCognition
Steve Whitley, Data Harvest

Transcript:

Carol Monaghan: Good morning. Welcome to this APPG meeting on STEM skills. My name is Carol Monaghan. I am the Member of Parliament for Glasgow North West and until about 18 month ago I was a physics teacher. I was actually teaching last Friday and I am teaching again this Friday so maybe I can still class myself as a physics teacher. I know we are waiting for a couple of people to arrive but I think we'll just press on. This morning's meeting is going to be recorded, so it's not Chatham House rules, so be aware of that but we are looking for recommendations to Government on what could be done to promote STEM education. If I kick off by saying a little about myself. I went to school in the 1980s. My parents were not particularly highly educated. My mum was a primary school teacher; my dad had no education at all. So, I had no pressure put upon me at all. No pre-conceptions and no slots that I had to fill. Pretty much I was left to my own devices and physics came very easily to me. I thoroughly enjoyed physics, so it seemed like a natural progression to go on and study physics at university. At that point there was no real careers guidance, there was no talk of what will you do when you leave university, it was simply, I carried on doing a subject that I enjoyed. When I was at university I realised that I found some of it a bit tougher than some of my classmates did, but for the ones who found it even tougher still, I found that I had a real talent for actually explaining things and putting across concepts to them. So teaching was something that about half way through my university career I decided I was going to do. So it was a conscious decision to enter the teaching profession. It wasn't a case of 'can't get a job doing something else'. So it definitely was a vocational choice for me. And I spent twenty years teaching in mainly comprehensive schools in Glasgow, although I did spend two years teaching in a private school. But most of my career was spent in comprehensive schools in Glasgow. Towards the end I was the head of physics and then head of science at a comprehensive very close to where I live and one that is within my constituency now. So I still have very close links to the physics community in Glasgow.

Scotland's situation is quite different; because we are much smaller, physics teachers know each other throughout the country, talk to each other. We have a set up called *Sputnik* where people can post material resources, good ideas and can chat about issues they're having. So that network is extremely important for physics teachers in Scotland. But there remains an issue, both in Scotland and across the UK, that we're not getting enough young people into STEM subjects, into physics, into engineering and into other areas as well. And we need to think seriously about how we are going to challenge this. There

are so many difficulties that I can see. The biggest difficulty I see is the perception of these jobs and the stereotypes that are portrayed. I know certainly that when you talk to young people about the possibility of studying engineering they think of dirty toilets. They think of boiler suits. They think of people with oil on their hands. And for young people, and particularly girls, these are not images that are useful to them. We talk about the engineer coming around to fix the TV aerial. It's not an engineer, it's a technician. These people do not have a degree in engineering…well, that's a sweeping statement but it's unlikely that they have a degree in engineering. So they're not chartered engineers. Engineering is considered in other countries as a high tariff career and in this country sadly it's not considered that way. This causes problems when we look at parents, parental pressure, these pre conceived slots people are expected to fill. I didn't have those pressures. But we also need to challenge I think stereotypes in the media as well. It's very easy for us to say, "We need to get science into the primary, we need to get science in the early years." But who's challenging Lego, when they talk about girls Lego sets and boys Lego sets? Who's challenging the makers of toys that are marketed particularly towards one gender? And even in Glasgow City Council there's an issue I have every year…every year the councillors are expected to provide a toy that will go to a child from a disadvantaged child. And they're to specify on it the age group and the gender, and to me a toy is a toy. By all means, if young girls want to play with pink Lego, fine. But so should young boys be encouraged to play with that Lego. This was hammered home to me when my five year old asked for boys Lego from Santa, because she perceived, even age five, that the girls Lego wasn't technical enough, there weren't enough moving parts. So we need to think about that.

In terms of school, and I believe Mr Gratnell shelving is here today, I don't know who that is….hello, I'm slightly starstruck… as a teacher we all know the importance of Gratnell shelving. I've got to say the double depth trays are particularly of interest to any teachers. But the quality of resources, things as simple as nicely ordered classrooms, a neat and tidy classroom, which is not necessarily the image we would have of a science classroom, but to keep thigns clean, neat, tidy, well ordered appeals to girls. Girls don't want to come in and see a mad professor working away at all of this, they want organisation. Data-logging is very important as well, when we talk about how we inspire young people, boys and girls. So we're not asking them to spend two hours plotting points on a graph. There are great skills in graph drawing but if the actual skill we're trying to get is interpretation and problem solving of those results, then data-logging is really important. Unfortunately, the issue for data-logging is the high cost, which makes it actually excludes a lot of schools from using it.

Final thing I'm going to say…I could talk for a long time but I know there are lots of you who want to talk. So the final thing I'm going to say is about the importance of role models. In my school there were four physics teachers, and three of those physics teachers were female, all about the same age as me, all with families, all normal people who really…that made a massive difference to the young people. We didn't quite have 50-50 uptake of physics, but we weren't far off it. Some years we were close to 45-55, so we did extremely well at getting girls into physics. Role models make a massive difference in that. But how can we encourage our best graduates – and I don't mean best graduate with first class honours, I mean our best graduates who have a real desire to be in the classroom – how can we tempt them away from lucrative careers, because I've talked about the shortages we've got in these key areas, how can we persuade them away from lucrative careers in industry to come and work in our classrooms for £25,000? It's a massive challenge and one which we need to think about carefully.

So I'm going to open the floor now to discussion. If I could ask you when you're speaking, can you introduce yourself so that we have a record of who's there? I will try to keep a note of who's who as well. If you could try to introduce yourself and your organisation, and we're looking for questions but more we're looking for suggestions, we're looking for answers, we're looking for practical steps that the government can be taking to improve STEM uptake and particularly STEM uptake for girls. So….I'll open it up.

Steve Emery: Steve Emery, Instruments Direct Services. You mentioned the word data-logging there. One thing I'm quite keen to explore and look at is…one of the things I find that schools are really missing now is technology in science. If, when children leave school they go to the big, wide world, they go to a place, they work on a project and they're generally working on software or software related instruments, using sensors, etc and I sometimes feel that at the moment that's not being addressed in schools. Now one solution we've tried to champion, always pushed, is one fairly easy solution is, a lot of kids now have smart phones and various other devices, or they might have an iPad or something at home. These can be

very easily integrated into a classroom using some modern sensors or modern apps, etc. I always find a lot of resistance to that in certain schools because they're afraid of kids might get distracted, etc. However, I think a policy based around that for me would solve one of the key issues that you mentioned there such as data-logging and other technology issues in science. Obviously that's one suggestion, one thing I'm eager to explore and get further various views on.

Carol Monaghan: That would certainly be a step in the right direction. I know we made a massive investment in data-logging in our school but the interfaces we were using were £500 each. So to buy five of them that's pretty much our budget wiped out for the entire year. So, it took a major decision to do that and it wasn't an easy one. So, yeah, absolutely, most kids are carrying around a more powerful computer than was available five years ago.

Steve Emery: Absolutely, and they're only getting more powerful and more complex and there's such great processing capability on those mobile phones. They're not just for texting and phone calls, Whatsapp, whatever you use, there's a lot, a lot of technology in those phones which could really be utilised very well.

Louise Archer: Louise Archer, I'm a professor at King's College London. So, we've been doing large scale research on what makes kids choose science or not. So we've done large scale longitudinal studies tracking them from the age of ten up to eighteen. So we have a lot of data on the factors that make a difference to that. And obviously there are lots of things, as you've pointed out, which are all playing a part. But I suppose I'm interested in the role of the educational system itself; given it's very hard to change what's going on in the media, actually this is one area that the government can look at and do something with. So, we know that the system of early specialisation in this country, the way that we stream kids in double and triple science that we don't do in other subjects, the fact that we have this system at A-Level which is specialised, we have greater severity in areas like physics. There's lots there that I would be hoping that the government would have a look at and think about as well. And also the work we're doing in our *Enterprising Science Project* is working with teachers to say, well how can you actually build kids' science capital? How can you teach in a way that better connects science to those kids who feel very distant from it? So, I'm talking particularly about kids from more socially disadvantaged backgrounds. And it does look like you can do things there, so I think there are ideas but I suppose my challenge is, is there a political will to look at that area?

Carol Monaghan: And of course you're talking about the English system and (inaudible) quite a different system where we don't do the early streaming but there are challenges in Scotland as well and a lot of them are similar, I think.

Patrick Hayes: Patrick Hayes, the British Educational Suppliers Association. I think the scale of the teacher shortage in science subjects in particular really shouldn't be underestimated. Prior to joining BESA I was at TES for ten years, which was the leading recruitment provider in the UK, and where the real shortages would be, where all the adverts would be, would be in science and maths jobs in particular. Last year for example, in terms of design and technology, so engineering – the first taste a lot of kids get of engineering – they only hit 41% of their quota of teachers needed for that subject. And I think what's happening now in particular in academies, is that unqualified teachers who do not have the subject knowledge are having to step in and teach science. So you talked very passionately about the physics teachers in your school. If you have teachers that are actually… have no subject knowledge, who are actually coming in and just effectively trying to manage a classroom, there is a real challenge there. And I think it is very important that actually that issue…the root causes of that issue…is dealt with rather than an attempt to modify the curriculum so that it will be more easy, for example, for a humanities teacher to teach issues and debates around science rather than core science knowledge.

The final point is, in terms of constructive solutions, there are lots of initiatives at the moment that are coming up to try and bring people who are actually further on in their career back into the classroom. So it's not just about capturing new graduates, it's also getting people, like Lucy Kellaway from the Financial Times, who this week resigned her job as a journalist, to go back into the classroom.

Carol Monaghan: Or possibly MPs.

Patrick Hayes: Or possibly MPs… (laughter)…and particularly people who work in the sciences, have got a career, they've paid off their mortgage and actually want to come back and do something really valuable for the last few years of their career. I think there's lots of innovative ways that are coming up and it's really important that we explore those and not just look for traditional routes into teaching.

Carol Monaghan: You've actually picked on a couple of things I get terribly animated about. One of them is academies abandoning teachers' pay scales, paying them below the agreed pay rates. How is that actually increasing the professionalism? Scotland, we don't have unqualified teachers. It is a profession still in Scotland. But the teaching shortages that you're describing exist there as well; possibly not as acutely but they certainly…they do exist. How do we tackle this issue with unqualified teachers though? And I think we need to be serious about treating the profession, both in terms of monetary reward but also in terms of value and how they're seen by the wider society and I think there are big challenges there with that.

Fiona Miller: So, I'm Fiona Miller from BT and we're committed to trying to create a culture of tech literacy. We're starting at primary school age - picking up on the point about stereotypes from a very early age – and we lead on the Barefoot computing project, which is resources for primary school teachers to help them teach the computing curriculum. And actually our ambition is to get tech literacy to be seen as a fundamental skill like literacy and numeracy and we're currently doing some research, in fact next week we're going to share a report that we've got, around that actually teaching of computational thinking and things at primary school age improves literacy, it improves numeracy, it can be used cross curriculum and pupils become better problem solvers, independent thinkers even at that very early age. And then we need to look at how can we show young people that actually tech – picking up on the tech piece particularly but this includes all of STEM really – that actually it underpins all jobs; a lot now and in the future, the future jobs. So primary school children in twenty years… we don't actually know what those jobs are going to be, but we do know that tech and digital skills are going to be in all of those jobs. So actually for us, tech literacy has to be a fundamental skill, cross curriculum and they're doing great stuff in Scotland actually with the Digital Strategy, and in Wales with their Digital Competence Framework, which actually embeds it throughout the education system, in order to get people to think about it in a different way.

Carol Monaghan: Are there ways of doing that economically for schools?

Fiona Miller: Well, computing is on the curriculum already, but what we don't want is for it to become a silo-ed subject. If it can be cross curriculum and to be shown…

Carol Monaghan: So you're using the resources already there in the school but using them in…

Fiona Miller: So these are at primary school level obviously but there are resources there that teachers can use in English lessons. We've heard of people using the idea of algorithms in tennis classes to try and break down how someone is making a swing in tennis, to be able to break it down into component parts and build it up again. So, all of these kind of problem solving steps can be used across curriculum and that's really I think one of the dangers of… particularly when you get to secondary school and people see ICT as being something that you do in a ICT lab, that it's kind of aside and it's geeky, and actually it's not for me, particularly when it comes to girls. And picking up on Louise's point as well, about needing to make sure that people understand the real life…the reality of these things and how it applies to something in the real world and you're not just learning physics for the sake of physics, you're actually learning it because…

Carol Monaghan: Physics is never just for (inaudible)… (laughter)

Fiona Miller: I was talking earlier about maths and people automatically say, "Oh, I'm not good at maths". And yet they could be using maths, in lots of different ways, in their jobs without actually seeing that they're good at maths. So how do you take that from the classroom and show how it applies to the real world.

Carol Monaghan: Which is what I think good teachers do very well. Possibly just need to see more of it. And I'm going to move to Kevin Courtney now, another physics teacher, so Kevin…

Kevin Courtney: I'm the General Secretary of the National Union of Teachers. As Carol said, a physics teacher. My daughter's currently studying Materials Engineering at Loughborough; had her year in industry last year, the only woman in an entire factory, being told to go down to the machine and bat your eyes at them to move yourself up the…but she's not phased by that. I want to come to what Louise was saying about the early specialisation, which we think is a real issue. When only a quarter of kids doing A-Levels are doing two or more STEM subjects, then early specialisation is cutting a lot of children off and I think the exam factories culture in schools, the pressure to get results in GCSEs which are completely….other countries, which I believe at the age of sixteen don't have a national qualification at sixteen which cuts kids off by putting…Now, that's a very big change that will be required to do anything substantial around that but I do think it's something that needs to be thought through by government. I'm wary of suggestions for changes to the curriculum, that we all have, but I'm wary about politicians making another change to the curriculum that doesn't take teachers or society as a whole with us. I think there needs to be a really considered period, and then a ten year programme of changing the curriculum so that we are taking people with us. I do think early specialisation is an issue that has to be dealt with.

Sophie Bessemer: It's a really quick one on that. It's exactly like…I don't know if you've seen the Head Teachers Roundtable recommendations recently, which have been all around that, particularly also at primary, the fact that end of Key Stage One and end of Key Stage Two, it's too narrow a curriculum then because you're just doing literacy and maths. Sorry, I'm from Third Space Learning. We do primary maths education, so I'm all for primary maths, it's just that (inaudible) stages they're not broadening out, and there's not enough science.

Carol Monaghan: Can I ask you a further question on that Kevin. I would have thought the EBacc would actually increase the uptake of science. Is that not your experience?

Kevin Courtney: It is. I think it's Fool's Gold for people who really interested in this subject because we're forcing kids. So science uptake has increased for GCSEs, technical subjects has decreased because they're not in the EBacc, and I think there's a problem about making a requirement rather than finding a way to encourage kids. Because if we don't change the exam culture around the thing at the same time, I think you could end up putting a lot of kids off further study.

Carol Monaghan: I think Tim had…

Tim Oates: Right, I'm just going to annoy so many people… (laughter). Ok. So the first thing is…

Carol Monaghan: Sorry, could you introduce yourself.

Tim Oates: Of course I can. So, Tim Oates, I am Group Director Assessment Research and Development at Cambridge Assessment, a big non-teaching department of Cambridge University and we work in 170 countries. I was involved in chairing the expert panel for their review of the national curriculum which has landed in schools relatively successfully. I'll pick a couple of things out of that. You've got to understand the nature of the problem. First, and I do hope….one of my key bits of advice to the group is to make sure you understand the nature of the problem. Because I've got some really profound misgivings about some of things that have been even said so far in this meeting in terms of whether it is an accurate representation of the nature of the problems that we actually have.

And let's just think about what Kevin has just said…really, really important. If the EB is having such an effect in terms of the balance of our curriculum, it's a rather useful policy instrument. Let's put that on the table, ok. So, let's just look at the nature of the problem. We've analysed the way in which your key theme that you introduced, the gendered nature of choice within schooling, enters into the schooling system and the way it manifests itself in labour market participation. To understand the nature of the problem you can look at all the cross sectional studies of kids at seven, eleven, fourteen, sixteen, eighteen, women in engineering, and you will look at all those cross sectional studies and you will reach conclusions and they will be the wrong ones. Because you need to look at cross sectional studies and the life trajectory. You have to understand what the feedback systems are within the economy, the signalling from the economy, in terms of which degree you take and why, and so on. And very few parliamentary groups have done that in respect of education. So the risk is you then do some things that are wrong.

Ok, so, let's just take this issue of narrowness, and narrowness of GCSE, and the fact that it's completely atypical, you know, we're the only country that have got high stakes assessments at sixteen. Rubbish. It's just not empirically true. So, you go around the world and there are high stakes examinations, there are high stakes assessments, often done in a very, very insecure way by teachers, all the way around the world. If you're in Germany and you take the Abitur, "isn't it broad, isn't it fantastic," because you will study a large number of subjects. How many examinations will you take? Three or four. What do the examinations look like, when you actually look at them, the questions, in the examinations?

A-Level; of course A-Level is completely atypical. Only England has narrow examinations at the age of eighteen, apart from: America, the Advanced Placement Award; Germany the Abitur; Finland the Abitur, I could go on. Singapore…

Carol Monaghan: Scotland doesn't.

Tim Oates: …because they've got A-Levels, ok. Now before we rush into changing the thing that we always change, because it's the easiest thing to change, and it's usually the wrong thing to change – qualifications – let's just think about the nature of the problem. So I'll pick up a key thing that Louise said; grade challenge in physics A-Level. I'll talk for about another thirty, forty seconds and then stop. So, physics is harder. Luckily, even with the EB, more people are taking physics. I mean, I predicted that it wouldn't happen but in fact they are. It's good news, good news actually. So, A-Level physics is hard. It's harder than many other. I've got all of the gradients here, I've got all of the data here. So Ofqual at the moment are thinking about how important it is to make all A-Levels the same level of difficulty. And indeed one Ofsted officer, with a great level of insight, noticed that further maths is harder than the other A-Levels. Clue could be in the name. So obviously one of the things we need to do is to make physics easier to align it with other A-Levels. Obviously that's what we need to do. Yeah, apart from the fact that the gendered nature of physics hasn't changed for thirty years. There's the data. The gendered nature of biology hasn't changed for thirty years. Think about all the changes in the education system that we've put in place over thirty years. Think about it. And of course physics, if we look back through the lens of Isaac Physics in Cambridge, Lisa Jardine- Wright and Mark Warner, making old physics questions from our archive available online from 1920, 1930, hard physics questions, harder than the physics questions in current A-Level. I hear the voices immediately: "Yeah, but that was when very few people took A-Level physics and you didn't need to get many marks to get a high grade." Apart from the fact that during the 1980s…1970s and 1980s, twice as many people took A-Level physics at that time…twice as many people took A-Level physics and you had to get a high mark to get a good grade, and the questions were much harder. We know that because we've done the empirical comparisons. So do we really want to, in order to feed through the skills that we need in the economy, want to make physics easier? What we know is that already, we are considering , in Cambridge, making physics a five year degree, not a four year degree, to make up for all the deficits coming through from the school system. So the remedy is simple, I think. Understand the nature of the problem and then use the effective levers. Look, if we want more people to take physics in GCSE, in A –Level, increase the funding two fold. Give it twice the number of points in the EB, give it twice the number of points in the UCAS tariff. Get all the signals going down to be much, much stronger. Don't change GCSE, don't change A-Level in the way in which it is being described because it frankly is exactly the wrong thing to do.

Carol Monaghan: I'm sure lots of people probably want to respond to that. I'm going to say a couple of things very quickly. I don't think what we want to do is get a certain number through doing a hard course. I want to widen it out to get as many doing it as possible. And having been in the classroom dealing with kids, making it as difficult as possible is not going to encourage…

Tim Oates: That's not what I said.

Carol Monaghan: Well…

Tim Oates: I said historically the education system… we have to look at the fact that these are so fixed. The gender figures in biology and physics are fixed because of complexities of the signalling going into schools from families, society and the economy, exacerbated by things that are done within schooling in terms of the tariff, league tables and so on. And it's complex and you have to recognise that complexity.

The second point is, at times in the history of our education system, we have done what we are trying to do now. And we need to think what we did to move away from that. If twice the number of people took A-Level physics in the past and got a higher grade in it, and knew more physics, what is it that we were doing then that created that situation? And the kind of things that are so frequently coming up at these kind of meetings are not an antidote to increasing the amount of knowledge that children achieve in these subjects in school. It's a difficult message, it's tough and it's against the zeitgeist. But it's there in our past…

Carol Monaghan: However, we would have had a lot of physics people studying physics, when you put them in the lab they would have been completely clueless. And you can't underestimate the wide range of skills and problem solving, and practical experience, that pupils are getting in labs now that's not just about being able to do physics problems, it's actually about developing problem solving skills that allow them to use their physics in other situations. This would have been physics in a box. Physics has to be an awful lot wider than that. But I'm going to move on as because there are hands up all over…

Tim Oates: I don't think that's true actually but we'll come back on that…

Carol Monaghan: Ok, sorry, gentleman here…

Will Akerman: Hi, I'm Will from MyKindaFuture. I have three physics O-Levels, you'll be pleased to know. How? You may ask. My company, My Kind of Future work with around a hundred of the largest employers and we bring those employers face to face with around 80,000 secondary school students each year. We work across sector and all of our company partners are keen to develop skills and careers of those young people, ultimately to help the skill gaps that those companies face. I totally agree with your points about future skills and IT being central. But I've got a complementary point to the last point that was made. And that is, all of our interventions with all of our employers are competing for those young people doing various subjects, and traditionally careers advice…there's been a big emphasis put on its impartiality and I don't think that is the way that we're actually going to shift the dial. For stakeholders – parents, teachers and young people – to realise actually that a career route in STEM versus a career route somewhere else won't lead to exactly the same outcomes. So I think, if we're going to shift the dial, we actually need to be a bit more transparent with destination data that parents can understand and actually give the encouragement to their students that teachers can understand that actually going into a career that is likely to be automated in ten years is not the same as a STEM career. I think an anecdote would be that if you show - the jam, jam challenge - if you show someone fifty different flavours of jam, they would choose marmite; they'd just kind of get boggled with it all. And I think that's a bit what we're doing with careers, we're just showing it's completely impartial, just pick any of these careers, they're all equally good – they're not. I think we should be a little bit more forthright in the destination.

Carol Monaghan: (Commons Bell ringing) you'll have to excuse the bells…I am writing people down as they're putting their hands up so…

Mhairi Crawford: I'm Mhairi Crawford, I'm from WISE and, nothing to do with this, but I'm another Glaswegian physicist (laughing).

Carol Monaghan: We get around…

Mhairi Crawford: We do, we get everywhere. There's a number of points I'd like to try and very quickly cover. Fiona earlier made a very good comment. I know, for people like me, girls self-select out of STEM. We, WISE, published some research a couple of years ago, which actually understands some of the reasons why they self-select out of STEM and some of it is unconscious bias which comes from Lego, it comes from the market, it also comes from our teachers and our parents. I'm lucky my mum was a biologist, my dad had no education, but they were happy to encourage me to go down the route of being this weird physicist person but a lot of children don't have that and what we do…we do a lot of work in encouraging employers but we're also working with national organisations like STEM Learning, we're looking to work with other organisations as well to actually go into schools and help girls realise that they can be a scientist. Girls, themselves, identify differently. They tend to associate with adjectives, boys tend to associate with verbs. So by looking at the adjectives they have strengths for, they can understand some of their personality characteristics and where that may have strengths in different careers and then, it is,

it's taking them down different scientific careers routes, opening their eyes. They can't choose a career if they don't know what's out there. So, again, it's…we're working to try and encourage schools to help raise awareness of the different careers. It's not career guidance, it's not saying go down this route but it's raising awareness of where a career in physics or where an apprenticeship in physics might take you. And I think it would be very interesting if the government could look to address the unconscious biases or work out how to work with teachers so that the segregation, not just, sort of, streamlining science from a very young age but also there are still people out there who go, "why would a girl want to do engineering?" If you look at some of the factories today they're streets ahead but people aren't aware of it and I think raising awareness in schools, and I don't have the answer of the best way to do that…we have one solution but I think raising the awareness and working together in a more comprehensive approach will possibly try and start making the difference.

Carol Monaghan: I know one of the things I used to do with the first year classes when they came in, so it was probably age eleven or twelve, they came in, it was the very first thing I did was to give them a blank sheet of paper and ask them to draw a scientist and…male, glasses, white coat and for me to stand there and say, "but I'm a scientist"…but they would go, "you don't look like one!". And it's that…it's, it's challenging these stereotypes by age eleven that are ingrained and it's very difficult to overcome that.

Mhairi Crawford: We do a lot of work with role models…as you were speaking earlier…a lot of companies will take women in now and that opens up eyes but actually a lot of it has been just raising awareness of…being an engineer did not mean working on a washing machine, working on a train or if it does mean…actually trains can be quite funky and it's raising that awareness and without that they're going, "well, it's not for me, I'm not interested in that because I don't know what it is."

Carol Monaghan: Thank you – question here, please.

Martina Ratto: I'm Martina Ratto from MyCognition. I absolutely agree that those social aspects are involved in the problem but I would like to pick up something that has been mentioned before about some baseline skills like problem solving skills. This is my company approach in seeing why there are still lots of kids struggling in studying and receiving good results in STEM subjects and the reason why is that there is a lack of cognitive skills at baseline. Subjects like maths require very good strength in working memory, for example, so the ability to store information and retrieve this in order to be able to solve the problem. So our approach is only partial, of course, but to try to look to give all the children from very different backgrounds, without caring about their backgrounds, the same tools to afford the study of this subject. So we try to provide personalised cognitive training implemented in a video game in order to be engaging. This is only an approach to our solution but I think that if all the teachers start to look at the baseline skills, not only academic achievement, but those skills that are required before, maybe all the kids will be able to afford this part of education.

Carol Monaghan: Thank you, we'll go here…

Julie Swan: Hi, I'm Julie Swan from Ofqual, Executive Director for General Qualifications – England. So I'd just like to, as you'd might expect, suggest that qualification reform, at this stage, isn't going to be a good move (laughter). We have been through a massive change and let's see how it pans out for GCSE and for A Level. The qualifications, I must stress, in England have been designed deliberately to encourage more practical skills development and much more freedom in the classroom for teachers to, hopefully, excite their students, particularly as they develop their practical skills. So a plea from me, and from Ofqual I'm sure, not to see qualification reform as a solution. I don't think you'll have taken this from Tim's comments but Ofqual certainly has inter-subject comparability on the table, we haven't decided that physics should be easier!

Carol Monaghan: Thank you, I'm trying to mark down people that I've noted, such as yourself so…

Kevin Courtney: Actually, David was before me, so you've got to rewind.

Carol Monaghan: Ok.

David Perks: So, I'm principal of a new free school, the East London Science School.

Carol Monaghan: Sorry, but could you give us your full name as well please.

David Perks: David Perks. So, the thing about our school that I set up, founded, is that we've solved the problem of girls not doing physics straightaway – they all do it! It's simple. All the children do physics, chemistry and biology from Year 7; we have no issue with it. So, to me if you want to solve this problem you can do it in ten seconds and just agree that it's done, it's finished, alright. Then, just to take it one step further because we're up to Year 10, so we're thinking about Sixth Forms, we surveyed them earlier on in the year: what subjects are you looking forward to doing? What's your favourite subject at A-Level? "Maths" – bingo! Why? Because we made it really important to them, we've been very insistent that if you're going to succeed in science, you've got to do maths, there's no way around it. The second one was physics, which I was very pleased about because I am also a physics teacher (laughter). But, the sort of difference I have about it is that I think, maybe, the thing that is missing from the debate at the moment is a belief that if we can get across the importance of the subject for its own sake, rather than having to dress it up or explain it in terms as having some sort of instrumental use, either in terms of employment or some other provision we're trying to deal with but I don't think you can solve gender inequality through physics, right, but you can teach people physics and I think if you just set out to do that, you've got a far better chance than not. And the trouble is that in a lot of schools we just don't, we avoid it and, therefore, there's less chance of a child seeing it as important, seeing that they should take it seriously and then seeing that they should succeed in it. So, I think that it's a cultural thing that we're dealing with here, about the importance of the subject, and actually, we're at a moment when science is at a peak in interest in the general public, you know, Brian Cox, et cetera, et cetera, you know, you can't get away from physics on TV these days. So it's not that they're not interested, it's not that the ladies aren't interested, it's not that we're not interested, it's that we don't believe we can do it and that's a different thing. I think we've got to have a bit more, sort of, belief educationally that we can do this and I'm very much with Tim on this, no watering down – that is not the answer. If you're a physicist, you can't water down. You're dealing with fundamental problems every time you ask a child a question because the moment they ask you a question back, you're going to think because it's not easy and I think that then engagement and taking that seriously and not shying away from that is half the problem and then that will then allow us to, sort of, take a step forward. Just on practical works, it's not really been mentioned too much, well I might have missed something at the beginning – so, the one great thing that the government did in the last two iterations was to get rid of coursework. It's the biggest thing you could have done to improve practical work in science because it means it's not an onerous duty for months, writing out the same damn experiment, year after year after year. The only trouble is I don't think we've encouraged people to actually take practical work seriously in labs in schools and people shying away from it quite badly, I think, and we need another way to reengage that now. Now, I'm not going to say we need to then put that back in to some kind of mechanistic, exact sort of qualifications, sort of, approach to this. I think that would kill it off again. But what we do need to do is say, "You know, what have we got as a gift that you can give children in secondary school?" Labs and experiments and that's what they want and why don't we do it? When we don't, we shy away from it. I think one thing that we really want to encourage is that take up and that push, and then you turn them in to little scientists and that's what they really want to do when they go to science lessons. If you can do that, then you're going to engage them. And by the way, yes, you can get girls to do engineering and all the rest of it. Done it, it's not a problem really. It's just, you've got to believe that you can do it and I think that's really where we're at. So I don't think it's about engagement, I think it's taking it seriously.

Kevin Courtney: You've got to have the teachers though.

Carol Monaghan: I was just about to say that!

David Perks: Well, that's the funny thing because if you take it seriously, the teachers will come to you. Alright, you take it seriously and take the subjects seriously and that you are treating this subject properly, then you'll get the teachers who want to do it.

Carol Monaghan: They'll come to your school but what schools are losing out as a result?

David Perks: Well, that's a bit mean! (laughter). I also, in my other hat, am a director of a charity called the Physics Factory, who go out and share our expertise with every secondary school we can in East London. We work with over forty schools and primary schools and the point is that if you set out like that you immediately become the focus for other people to reinvigorate their own understanding and that's something I think is really, really important.

Carol Monaghan: Can I just say on the practicals, we talked about that. One thing that's happening in Scotland is we're trying to get away from that. We're not there yet. We still have these really time consuming practicals but one of the things that's been tried is, actually, examining a practical set up that they should have had experience of in class and that's, kind of, forcing the issue slightly. Anyway, gentleman next to you, I think is next.

Dr Rhys Morgan: Thank you very much. Rhys Morgan, Director of Education at the Royal Academy of Engineering. I've never heard of engineers fixing toilets before – I've heard all sorts of things…

Carol Monaghan: No, I think I said manky toilets, not fixing toilets.

Dr Rhys Morgan: Oh, manky toilets, well… I haven't heard or seen that. Just picking up on a couple of points. I thought physics was in the curriculum, so it is compulsory and everyone has to do it from the age of…

David Perks: Not as an examination.

Dr Rhys Morgan: No, everyone has to do it from the age of eleven until fourteen and you can't get away from not doing it and, you know, you do separate it at the age of fourteen in to double science and triple science, so I accept that but you still had to do physics, you can't get away with it. I actually agree on the point of not making physics easier. The problem I think we have is that schools won't allow students to progress to A-Level without having an A grade in physics and that's anecdotal but there's a lot of schools showing that and so compared with other subjects, such as English or History or whatever, where they might accept a B grade to take you on, that's where the problem is. So, it's about accountability measures, it's about performance tables. That's driving that decision making. There's a couple of points I want to make. On shortages of teachers, the academy is working with the Institute of Physics, at the moment, and the Gatsby Foundation to look at recruiting engineering graduates to physics, mathematics, design technology and computing - engineering graduates can teach all of those subjects. The problem at the moment we have is that schools are very siloed. We have the science block and they want to keep their science teachers there, the maths teachers don't really, yours might be an exception David [Perks], but in most schools they are geographically separate, in the school premises so they do not talk to each other; you have this very siloed approach. So science, if we're trying to encouraging engineering, you know the science doesn't talk to maths, certainly doesn't talk to D & T and computing is often with business studies and so this lack of, kind of, STEM crossover, across all those subjects. So, the academy is working with, we're working with DfE, to look at how we might approach engineering graduates to take up some of those subjects but engineering graduates are not going to want to teach biology or chemistry so it's finding other subject combinations that we can use. I'm concerned about the proliferation of STEM outreach. We did a piece of work earlier this summer, we counted over six hundred organisations that do, kind of third party organisations, that do STEM outreach in schools and all claim to have a huge impact and yet there's absolutely no evidence. This doesn't include universities or employers either. I gave up counting as there's just so much going on, so much duplication of effort and there's so much low impact effort and despite your comments Tim about the increasing of A Level physics, it's actually relatively small over those five years, it's only about five thousand, given all that effort that you've all put in, so we really need to look at measuring impact and employers have a responsibility to stop funding, kind of, activities that go on in schools without any kind of meaningful impact. I wanted to also mention, this is really important, we've been focusing on maths and physics A Levels and, you know, the importance of them, we haven't talked at all about vocational and educational training, we haven't talked about apprenticeships. I feel there's just as much shortages in engineering in technician roles as there is in professional roles and actually, even on professional roles, only about sixty percent of engineering undergraduates have a maths A Level going into maths degrees, going into engineering degrees, and only just over fifty percent have a physics A Level. So we talk about these being the prerequisite subjects for engineering – it is not true. Of course it's true of Cambridge and it is true of the Russell Group Universities but there are one hundred and eighty two institutions offering engineering degrees; one hundred and ten universities. We focus on this very narrow set of the most selective and say that you have to have this, you have to have that – it is not true. So, we need to open the dialogue, talk about vocational education and apprenticeships and that comes back to careers guidance and parity of esteem on these different pathways through the education system. We certainly don't do enough about that and I'd like to see much more policy engagement around that. We do have the post-sixteen plan, actually there is a lot to applaud in the proposals by David Sainsbury, narrowing the number of qualifications and the Academy's

working to help shape those. The final thing I wanted to say, just going back to your very first point, is around public perceptions – hard hats, oily rags, greasy overalls and so on. The Academy is launching a major campaign next year to rebrand engineering, effectively; reposition engineering in the public mind-set because I think this comes back to the careers guidance, but also STEM capital, science capital, so we are launching a national advertising, PR campaign to break down the stereotypes, highlight engineering as a human-centred activity because engineers do work to help society. We don't do it just for the fun of it, you know, we are there to support society, improving the way we live. So, we'll be launching that and we're very keen to have as many stakeholders engaging in that project as we can. I'll leave it at that as I know other people want to speak.

Carol Monaghan: Thank you very much, a lot of food for thought within that. Gentleman over here.

Steve Whitley: Hi, Steve Whitley from Data Harvest. For the last thirty years we've been designing and manufacturing equipment that's used in secondary schools, data-loggers, and some controlled equipment, and for the last twenty years we've been doing it to primary schools. And there's a couple of things I'd like to, sort of, pick up on. First of all that proliferation of people offering STEM courses, I'm sorry we join that culprit category. And the reason we do that is because we have seen, over the years, removal of the support systems for schools, both secondary and primary, particularly in primary, and so we find ourselves in a position where the people that we want to actually teach STEM to our students have got little or no skill set, particularly if you go to primary. They're not science experts and yet they're expected to deliver science and what that means is that they avoid giving the science education, the students arrive at secondary school with no interest in science and technology, they've got to catch up to actually get to a level and I think we don't pay enough attention to what really makes a student pick a lesson or a subject – it's the one that they like doing! If they've not done science and then they're suddenly thrown into science when they reach secondary school and it's difficult because they've got no backing, no background, is it a surprise that they're not going to take it? I remember I took physics at school and every other lesson I took was aimed at being the easiest subject I could get away with but physics fascinated me so I took physics, you know. And I also think, yes, there is definitely society and parent pressure but let's not exclude student pressure. If those students want to do physics or want to do engineering, their parents will bend to that will – that's certainly my experience as a parent!

Carol Monaghan: How would you challenge the lack of confidence, then, in primaries?

Steve Whitley: I think what the gentleman said here is absolutely right [points at Dr Rhys Morgan]. We've got all these very small and disparate things happening, somehow we pool this together and can we have some uniform approach to support and train teachers, both in primary and secondary, to give them online CPD, to give them whatever it is we need, advisory or support services, because I think if they are happy and content to deliver that subject, they will have confidence, that will get reflected in the students and the numbers will go up.

Dr Rhys Morgan: We do have STEM learning in the National STEM Centre, in York and…

Steve Whitley: And it's wonderful. We do a lot of work with them. You know, but even that has seen its funding going down and down and the regional centres closing because when they arrived…

Dr Rhys Morgan: Well, they've changed model to the science partnership schools rather than the regional centres but that is the kind of…we should make far more use and far too few schools are actually allowing teachers to go out and do subject specific CPD in the National STEM centre, in York, or…

Carol Monaghan: Part of that, of course, is because there wouldn't be any teachers left in the school to teach their class, which is part of the challenge.

Dr Rhys Morgan: Absolutely.

Dr Mhairi Crawford: No, some of the sessions at STEM learning, because we're partnering with them while measuring the impact study of our work… they do actually offer placement teachers and they're still not getting take up, which is very different, for example, to CERC which I'm sure you're aware…

Carol Monaghan: I think, I mean, we have this in Scotland as well, where we'd offer funds for a replacement teacher but the replacement teacher didn't exist even though the funds were there.

Steve Whitley: I think we should be looking today more at online learning. You know, in my organisation almost all of my engineers and programmers et cetera do online training courses so why can't we do more of that with teachers?

Carol Monaghan: Gentleman here.

Chris Ratcliffe: Thank you, Chris Ratcliffe from Scholastic. We focus quite a lot on primary and we've just started doing a bit of work with secondary, we're a publisher. Taking on a bit from what Steve [Whitley] was saying earlier around training and a need for training in primary subjects, we work with another supplier to schools very closely, who give training, they do workshops with students and teachers and they offer free training to schools and, actually, go and deliver it in schools and they can't give it away because there isn't a perceived need from the primary schools to take it. We do lots of assessments, we do them at Key Stage Two, we just launched a baseline test for Key Stage Three, so the children that are going in to Year Seven, across all the subjects. What we find, in Year Seven and the transition managers is that English and Maths, they're quite happy with because they get a plethora of data for English and Maths, especially with grammar, reading and straight maths but with all of the other subjects there is no information coming out. So there's no…the science test at Key Stage Two is a sample, so there's no real requirement, if you're an academy, to teach science, necessarily, certainly in the way that secondary schools would want it taught at primary school. And if you are an academy, which the majority of English secondary schools are, you haven't necessarily got a requirement to teach the subjects at Key Stage Three either. It's in the curriculum but you're an academy so you can get around the rules so I think that you…you sit down, and we've talked a lot about science and maths here, but you sit down as I have over the summer holidays with some science teachers and some technology teachers. The science teachers were relatively happy with what they had to get through during Key Stage Three, especially the schools that still had a three year Key Stage Three and shortening that to two years is affecting a lot of…what you need to get through in that time but you sit down with the teachers and the heads of department for design and technology or food technology and all of the other technology subjects and they look at what they have to get through and they say, "well, I've only got six weeks a year to teach this because it's done on a rotation system". So, there isn't the time, there isn't the focus that is needed and whether that's because there is designed SATS and I'm not putting my hand in the air to put that back on the table but what the focus is that drives the need in the school isn't there and I don't think it's because teachers don't want to teach it. Every teacher I come across is incredibly excited by teaching anything other than a fronted adverbial but it's…there is not necessarily the need at the moment to teach those subjects.

Carol Monaghan: Unless it's required, it's not going to…

Chris Ratcliffe: Well, unfortunately I think so…

Carol Monaghan: The lady at the back, there.

Anne-Marie Shand: I am Anne-Marie Shand from Pearson Education, we are a publisher and I do a variety of things in science, which is quite strange as I, unlike most of the people in this room, don't have a degree in science. But I have done two projects with the Wellcome Trust where we distributed science kit boxes out to every school in the country, including Scotland and Northern Ireland and Wales, and I also manage, or have managed, A Level science publishing and I've helped with the A Level maths publishing as well so I've been quite lucky to get the whole spectrum and there's been a few things said. One of them, I was forced to do physics as a student and I loved it when I had a great teacher and I had a great teacher when I was about sixteen and he was desperate for me to do it until I was eighteen – I was doing an European Baccalaureate so I did eleven subjects until I was eighteen; I didn't do three! So I have a lot of knowledge about very little. The thing that put me off the physics wasn't the great teacher, it was the teacher that stank of horses and was horrible to me for four years so I think there is something about and I wouldn't say that all…I'm married to a physicist and he has a PhD, I got over my… but the issue is, you know, are the people who are teaching the subject: one, do they know that subject well? Because there are a number of people I've met who don't, actually, have a very secure understanding themselves. And secondly, are they people who really should be there in the classroom, you know, do they sell their subject? So that would be one thing. The other thing is people shying away from practical work. At A Level, they have to do core practicals now and at GCSE they're having core practicals and I know that there is a massive fear in schools now, just by looking at the dues on the practical book that we just published, they're flying out of the door and we have done no marketing on them at all! So, there is a

huge fear around practicals…I shouldn't be saying this to Scholastic! (laughter). There is a huge fear because suddenly they're being told, "your students are going to be examined on the practical work that they are doing," and there are teachers who have been teaching science who, I've spoken to them, and they say, "Ooh, I've been doing practicals as a nice add on at the end, I didn't realise that they had to learn something from it," and I'm sitting there listening to this thinking, what on earth have you been doing? So, I think it's great that there's more of a focus on the core practicals but I think one, sorry I'm mixing up all my things, but the technicians are not there and a lot of the time the teachers will rely on the technicians to know which chemical you can mix with which, how to set up practicals and often you get some very well qualified technicians with a PhD and everything else, but you also get some who don't have that understanding. You have a lot of teachers who are very scared of doing practicals and a couple of phone calls that I've had from people who have performed core practicals, twice where they exploded the first time because they haven't dissolved some granules so they did it again, same class at the same time, and, again, they got another explosion and it's that lack of knowledge, again, that is quite scary.

Carol Monaghan: Or preparation?

Anne-Marie Shand: Yeah, I do wonder about the suing area! So, I think, certainly, the issue around technicians and people who know how to set up core practicals, issues around people feeling confident enough to be able to teach the subject in a really interesting way is a difficult one to address. I think I'm agreeing with a lot of people with the Wellcome Trust projects that we did, we sent, you know, twenty four thousand boxes out to every single school in the…every single primary school and there were people not using it and we made it as…you know, I had…the first tender we did we put a puppet in the box because we thought when they open the box if they see a load of science equipment they're going to have a fit. If they see a puppet they might actually start going deeper into that box. So there is a huge fear, you know, in primary schools about teaching science and also science knowledge is not there so a lot of the time they'll teach misconceptions that then need to be rectified later on. I know that getting teachers to do CPD is not ideal. Online CPD teachers are absolutely flat out. They've gone through massive curriculum change. They are, you know, the hours that they work are unbelievable. I'm a primary school trained teacher, I've taught for quite a few years and somebody said to me recently, "would you go back right now?" And I said, "no". And they said, "well, why not?" I said, "I love teaching, I absolutely love it, but the hours that are required are incredible", so to ask them to do online training in the evening is great but…

Steve Whitley: I'm quite sure they should be doing it in the day, actually.

Anne-Marie Shand: Exactly. I mean, I think, certainly, we're going down the route of offering some sort of advanced qualification for teachers, you know, where you are a science specialist and where they can further their career or, you know, something around that would be extremely useful.

Steve Whitley: In the old days we had a twenty day primary science course and a teacher would come out for about six weeks and have twenty days of training and then be the nominated science co-ordinator and that always went exceptionally well.

Carol Monaghan: Some schools do, of course, have a science specialist in primary but not all of them have it. I am conscious of the time and we were meant to be finished four minutes ago so I am going to draw the official meeting to an end.