

Education Committee

Oral evidence: [Fourth Industrial Revolution](#), HC 1007

Tuesday 2 April 2019

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Members present: Robert Halfon (Chair); Marion Fellows; Emma Hardy; Trudy Harrison; Ian Mearns.

Questions 266 - 288

Witnesses

I: Minister Liang-Gee Chen, Taiwan Ministry of Science and Technology, Professor Yuh-Jzer Joung, Director General, Science and Technology Policy Research and Information Centre, Professor Jiun-Huei Protty Wu, Director of Science and Technology, Taipei Representative Office in the UK, and Dr Yun-Nung Chen, Assistant Professor, Department of Computer Science and Information Engineering, National Taiwan University.

Written evidence from witnesses:

[Taipei Representative Office in the UK](#)



Examination of witnesses

Witnesses: Minister Liang-Gee Chen, Professor Yuh-Jzer Joung, Professor Jiun-Huei Protz Wu and Dr Yun-Nung Chen.

Q266 **Chair:** Good morning. Thank you very much for coming to our Committee today. It is a huge honour for our Committee to have you here—the Minister, the professors and the doctors—and of course we extend a big welcome to the ambassador of Taiwan. To all the special guests and members of the public, thank you for coming today. This inquiry is about the fourth industrial revolution and how our education system should adapt to it. We are very interested in some of the work that has been going on in Taiwan in relation to the fourth industrial revolution and education.

For the benefit of those people watching on television and on the internet, could you please introduce yourselves, from our left to right? If you could speak quite loudly, that would be great, because the acoustics in this room are not brilliant—it is a very old building. Thank you.

Professor Wu: It is a great honour to be here. My name is Protz Wu. I am a professor from National Taiwan University currently on secondment, serving as the Director of Science and Technology in the Representative Office in the UK. I have been involved in national entry exams for universities for more than 10 years and I have been an author of a high school textbook and middle school textbooks in natural sciences for 15 years.

Minister Chen: Thank you and good morning. I am Liang-Gee Chen. Currently I am the Minister for the Ministry of Science and Technology. Before that I was the Deputy Minister for the Ministry of Education, also in charge of some of the education system revolution. I am also a professor in electrical engineering at National Taiwan University. Thank you for the chance to speak today. We hope we can bring friendship and also some good ideas for the education system.

Professor Joung: Good morning. My name is Yuh-Jzer Joung. I am also a professor at National Taiwan University. I am in the Management School and I currently work for the Ministry of Science and Technology to study policy making.

Dr Chen: Hi, everyone. I am an assistant professor in the Computer Science Department of National Taiwan University. I graduated from Carnegie Mellon University and my field is natural language processing and conversational AI.

Q267 **Chair:** Thank you. Previously Taiwan had an exam-based system and focused on memorisation and knowledge of the pupils. In 2014 you made reforms to change your education system. Why did you make those reforms when you were very high in the league tables up to 2014? Why, despite that, did you make reforms away from a knowledge-based



memorisation education system?

Professor Wu: As you mentioned, Taiwan has traditionally been a country of very much an exam-based educational system, and the young kids received pressure from that. In the face of the fourth industrial revolution, we thought the style of education should be more interdisciplinary, so instead of having the young people learning things in subjects, we actually first changed the way of the exam. We all know that the way of the exam basically drives the way of teaching, which in turn drives the way of learning, so to make any change you have to change the way of examination.

We started a bit earlier, with changes to the exam system in 1994, to come up with the GSAT, the general scholastic ability test. In that, we have five subjects. That means that you do not only the Chinese, English and mathematics, but also natural science as a subject and social science as a subject. In natural science, we are including physics, chemistry, biology and earth science. To cope with that and make the way of teaching more cross-subject, as we have mentioned, we started changing the curriculum a bit earlier. It has been through a phase of about 10 years.

Now we are pretty much mature, in a stage of having the entry exam to university in a format that, for example, the subjects of natural sciences are mixed together in one exam and the same for the social sciences. We are still making changes and that is to get ready for the new challenge.

Chair: Would anyone else like to comment?

Dr Chen: From my personal perspective, usually the high school student will learn basic physics and some maths because these subjects are related to different fields. Having skills in programming is very important, especially because programming and software are currently incorporated into different fields, so they may still benefit from this skill. Because previously our students did not have any background in programming and they did not know what computer science was, I hope we can motivate them to learn from this field and try to understand the basics so that they can benefit their own direction.

Minister Chen: The logical thinking behind the change, as Professor Wu has mentioned, was for the entry exam to change in other ways, based more on a problem-solving teaching system. The change in examination is changing the teaching and also the learning. Having students approach it more on a problem-solving basis means that there may well be more multidiscipline, so the older system can change to fit the multidiscipline requirements, including the new demands of industry 4.0. They request a coding system because almost every industry has changed to autonomous control, and control systems and the computer systems are important.



There is also the combination with some sensing ideas. The sensing means the smarts of manufacturing, so all these disciplines need to be put together during the student's learning. That is why we initiated this big change, starting from the learning, and then through the entry exam by changing the system of evaluation.

Q268 Chair: How have your 2014 reforms improved creativity and critical thinking? How do these adaptations tie in with your preparations for the fourth industrial revolution?

Minister Chen: I think the world is already changing, and not just in the quality of manufacturing, which also means the second industrial revolution. For the so-called industry 4.0—some people say it is the fourth industrial revolution because it comes from data and different kinds of thinking—so innovation is more important than just doing the manufacturing.

Talking about innovation, we need to teach our students to start with design thinking, like exploring creativity and humanity, because all innovation comes back to human activities, combined with social science and even humanities science. That is a different way of thinking for all the training systems. Even inside universities we are also changing some of the curriculum now, to request that students learn more about innovation. I think that also applies for society; that's the value creation after students have a career and they enter the jobs market.

Professor Wu: In terms of the content, the curriculum itself has not been changed much; it is more the way the time is shared for different ages. In Taiwan, for the high school part we do have this vocational track. As I mentioned earlier, our entrance exam for universities is actually the key to changing how people learn. In Taiwan, when you reach age 18, basically you face three national exam systems.

The first exam system is the one we have been running for more than half a century, called the Advanced Subjects Test (AST). Basically, there are two or three days of exams in early July for those people who want to go to university. That system is still there, but before that, in January of the same year, we have this new exam system that I mentioned earlier, the GSAT, which started in 1994. You take that exam in four or five subjects, and the outcome will determine whether you should be going into that academic career. Then the third exam system will be the vocational education system.

In terms of what is new about the contents of our curriculum, with regard to the fourth industrial revolution, that is probably the addition of, for example, artificial intelligence, the internet of things and robotics. We add those ingredients as a compulsory part for the vocational curriculum.

For the other two exam systems, the contents have not changed too much, but the way students are examined has changed a lot over the past 10 years. A compulsory part of the exam is a specific section that



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requires a mix of knowledge across subjects. For example, as I mentioned, we have a subject called natural science. In that exam paper it is compulsory to have a section with questions that involve at least two subjects. Sometimes the answers cannot be obtained from the textbook; the answer can be obtained only by analysing the information given in the exam paper, so we call it analysis and integration capability.

With this new design for the exam, you really drive the teacher to design their own questions in the class, so that their students, when it comes to sit in the exam, will be more ready and not scared by these kinds of questions. It requires them not just to memorise knowledge by itself, but at the same time to learn about problem solving. It is more about problem solving. Nowadays we have this inflation of knowledge, so it is impossible to learn everything to get ready. You solve a problem at the time when it is necessary by analysing the information you have at hand.

As I mentioned, this change in the style of examination does influence the way of teaching. We have been doing this for about 10 years already and so far we have received very strong positive feedback and appreciation from the schools.

Q269 Chair: Finally, before I pass you on to my colleagues, you have set up community colleges in Taiwan—I think they were established in 1998. Can you just explain what they were for, why you did that and if you have seen a rise in adult education because as a result? Have the community colleges led to an increase in Taiwan's productivity?

Minister Chen: The introduction of the community colleges is to face the changing of the proportion of the population. The basic learner is for the so-called adult education. Taiwan has had to adopt to having a higher proportion of people who have had to retired from their main job. Some of our professors proposed that we needed community colleges in order to give those people the opportunity to go back to school to learn new things. That is where the idea came from. As a result of this initiative, we established lots of community colleges in different cities. Currently it is very popular for adult education.

With regard to the curriculum of the community colleges, their main intake is mostly retired people, or people who have just left their main job. So the purpose of community college is not to try to rebuild their productivity; it tries maybe to enrich their lives and the curriculum covers a very broad range of disciplines. Some maybe focus on artwork or on different kinds of skills. In general, they create creativity for society. It also shows that in Taiwan we are now more creative, and not just for the so-called traditional manufacturing industry, by allowing them to take up any kinds of courses.

Q270 Chair: Briefly, have these colleges been successful? Do they have good outcomes?



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Minister Chen: I think they are very successful. The proportion of people who attend the community colleges is quite large, and they can pick up one or several courses, depending on their time, and they can jump into the school again and again.

Q271 **Chair:** They have good outcomes for the students?

Professor Wu: Yes, they are pretty popular, because I also teach part-time in these community colleges. The original idea was for adults to have another opportunity, because being an adult, when you are working from 9 am to 5 pm on a daily basis, it is very challenging for them to sit in any class and have an opportunity to learn things properly. Normally we conduct that kind of thing in the evening, so after their meal they can take it easy, sitting in the place to learn things, according to their choice, because the courses are optional.

What is good here is that we have a framework there already. It is not quite that much about the fourth industrial revolution, but the framework is there and people know that there is a place with opportunities for adults to learn new things. The next step will be putting in place the ingredients for industry 4.0, and we are working on that at the moment.

Minister Chen: Usually colleges require teachers to have certain qualifications, but these community colleges allow the profession of any specialty or expertise to teach, and this opens the culture to diverse skills. That is very successful in Taiwan's society.

Professor Wu: There are modules in the colleges.

Q272 **Ian Mearns:** How is your formal education system adapting, and what more do you need to do to prepare Taiwan's young people for the fourth industrial revolution? Do you still have much more to do?

Professor Wu: Yes. It took us a while first to change the way students do examinations, although we think it is pretty stable now. Last year, 2018, we started another kind of reform of the exam system which will last for four years—we started in 2018 and it is supposed to finish in 2022. Taiwan has very much an exam-based system, so the knowledge in the way of teaching is over-modularized. We want people to learn things in a more integrated way, so that is why we changed the exam system.

We always talk about the importance of STEM subjects—science, technology, engineering and maths—especially for the high-tech market in Taiwan. We have an over-production of STEM degrees, which is the opposite of many other developed countries. Now we are pulling things back a little bit for the past 10 years doing this interdisciplinary kind of reform for the exam system, but we somehow feel that we are a little bit overshooting the emphasis on interdisciplinary learning, because up until last year all high school kids up to the age of 18 had to do all the subjects, including natural sciences and social sciences. Starting this



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year, students are allowed to choose not to take one of the subjects, so that their exam pressure can be reduced.

Perhaps that has not answered your question very directly, but let me add that in Taiwan the way we do examinations is being changed and there is already a pendulum effect. We are still trying, but it is a good thing that we already started trying this about 10 years ago. We think we are now more or less ready to converge to the position where we should be in face the fourth industrial revolution.

Q273 Ian Mearns: Are you having to undergo a radical amount of teacher training or retraining?

Professor Wu: Yes, we are doing that.

Minister Chen: For the formal education, the change still keeps going, because we still have a lot to do. As I say, we are changing the exam-based teaching system to more of a problem-solving system. To prepare for industry 4.0, we need to inspire students to learn coding and computing skills.

The other point is learning by doing, for example by providing enough equipment and resources to guide a student so that they can learn by doing an activity. We also include some of the innovation courses, even in high school, so we also provide some optional courses. Some are very professional, so they can even join together with the professor in the university. We try to make the system more selective for the student, with the multiple disciplines together, so that the learner can then face future challenges. Some of the changes still keep going.

Professor Wu: Maybe I can just add one more thing. In this vocational track for high schools we emphasise the concept of clusters, rather than departments, which exist for a long time in history, so traditionally they learn skills in a very specific subject only in a single department. In recent years we started to require all these vocational high schools to form clusters inside a school and across the schools, and even across a city or across our country, because we conduct this practice in industry during school hours so that they can do the practice in industry. Very often they get their licence even before graduating from high school. I am emphasising the concept of clusters, involving several departments all together. We lay this out in the curriculum, so it is compulsory for vocational high schools to conduct their teaching in that way.

Minister Chen: Talking about the retraining, we do have the so-called vocational education act. Every six years, all teachers in the vocational education system must take at least a half-year to retrain in industry. That is very special. This was decided by our Parliament. We have this system already.

Q274 Trudy Harrison: Good morning. Could you tell us a little bit about Taiwan's artificial intelligence manufacturing research centre, which is a bit of a mouthful? If you could start at this side of the panel and explain



to me a little bit about that.

Minister Chen: Last year we established four different artificial intelligence research centres. The one you mention is focused on smart manufacturing. Artificial intelligence has several major applications, such as medical care. We have two centres working on this area. For smart manufacturing, we think it is also very important, so we have one research centre focused on smart manufacturing. The idea is to join together with industry in Taiwan. We have a huge manufacturing industry, and we hope that we can use that advanced technology to help them, by promoting value creation, to face new challenges. The research centre is working jointly with industry and university professors. They have combined to have advance and also the data correlation for training and learning. Those are some of the ideas that we established in the universities.

Q275 **Trudy Harrison:** Do you have apprenticeships in Taiwan and, if so, do they focus on AI as well? You talked about learning—

Minister Chen: Maybe Professor Chen can answer the question better, because she is the AI expert.

Q276 **Trudy Harrison:** To explain, an apprenticeship is a way of learning while being on the job. A young person—at any age; it is not necessarily a young person—could gain a qualification while also working. I just wonder whether you have that combination in Taiwan.

Dr Chen: There is no universal official one, but I think there are some non-profit organisations that have built schools, and then the employees in the company can learn AI and try to apply it to their current job—because there are a lot of IT industries that previously did consider using AI—after they enter the school. It is an unofficial school, and they ask a lot of professors to teach some AI-related course, for example, for text processing or computer vision. They will get a basic background about AI and try to think about how to apply this to their own job.

The students from that school are maybe over 40, so in the middle age of their career. But I think that for the student the current situation is that we provide a lot of AI courses to both students and also the adults so they can learn from online courses as well.

Minister Chen: We have two ways of training students in the vocational education system. They will need to work within the industry for one or even two semesters, going to the factory to join the workers. The other way is that we provide some courses. For example, we have online courses and also physical courses that provide a means of learning or a means of labour. Those courses are provided to current employees.

Professor Wu: For the vocational high schools, that has already been there for a long time. They can do things in industry, mentored by some industry expert, and at the same time getting the credits to graduate from high school. Even for universities, I would not say that it is popular,



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but an increasing number of departments are starting to do that, especially for the final year. Twenty years ago we followed more or less the same path as yours, so from the 1990s you had inflation in the number of universities, and we had the same. Some of those were not originally universities, so they started as a polytech or vocational-based colleges. Those kinds of universities are increasingly adopting the practice of having students spend a final year or final semester in industry to earn credits before graduating.

Professor Jung: I would like to add one more comment about AI. This one is also related to our transfer from an exam-based education to a more creative and innovative system. In the Southern Scientific Park we have a maker space dedicated to robotics design where the student can learn by doing. There are a lot of tools for them to use in order to learn how to assemble robotics.

Q277 **Ian Mearns:** I suppose this is a diplomatic question really. Which countries does Taiwan see as its main competitors in terms of the growth in this area, working towards the fourth industrial revolution? Which countries do you see as your main competitors?

Professor Wu: Competitors in terms of—

Chair: Education and what you are doing.

Minister Chen: It is a country or—

Ian Mearns: The question is: which countries do you see as your main competitors?

Chair: In terms of education and skills in what they are doing. What other countries are doing—

Ian Mearns: In terms of making the change that needs to be done, yes.

Professor Wu: Speaking for myself, I do not feel that I am competing with other people in education, because Taiwan is a very special place in many ways. We always focus very much on what we need and what the new generation needs. In that regard we have sent out a lot of delegations to different countries, for example to Germany, Finland and Austria, and they are all very advanced in facing the fourth industrial revolution. We organise that on a yearly basis with the Ministry of Education.

We know that there is no single solution or answer to the same problem, especially for education. It depends strongly on your cultural background, your tradition and a lot of other things, including your political situation sometimes. Basically we just keep our eyes open and try not to be left behind and then keep updated about what other people are doing. We will see.

Minister Chen: That is a very interesting question. We always say that Taiwan's education is unique. Fundamentally, the system has been



designed and adopted from the Japanese system, because for a couple of years the Japanese Government took over the Taiwan islands, so the whole education system, especially the elementary system, is similar to the Japanese system. However, after the second world war we got a lot of support from western countries, especially America. A lot of our teachers are educated in America. We also have a lot of international corporations, and most of our university professors retrain in American universities and come back. So we have come out with a new model idea of the modern education system.

Of course, some of those ideas have come from the UK, so we have tried to combine the best of the different teaching systems with the culture of Taiwan. Taiwan is a small island, so we have some special thinking, and teachers have a lot of passion. In our society teachers have quite a high social position, so they are always looking to adapt the system. Somehow we have a very unique system and we try to inspire all the students—every one of them—to become useful for society.

Q278 Emma Hardy: Good morning. I am very interested in what you said about multidisciplinary learning. What were the barriers you faced to setting that up, and how easy or difficult has it been to introduce multidisciplinary learning?

Professor Wu: As mentioned already, it is about the capability of the teachers, because the teachers were trained in some way that they specialise in one subject. When we ask the young generation to learn many of them (subjects) at the same time also with the capability for integration, we need to have teachers of similar capability. That is why we have retraining programmes for teachers, in the face of this change in the exam system, which I have mentioned many times. We basically started everything from changing the way we do the entry exam to universities.

At the beginning it was quite painful, because we were facing not only teachers and students but also parents, and especially because we had the previous exam system for such a long time and everybody knew the rules of the game. Education is very much the highlight for the parents, in any family. Parents typically start planning their children's education at birth. Now we are changing the rules and that will certainly affect their original plan, so we do get some pressure from parents.

We conduct a lot of hearings with parents associations, school associations and so on, so that later we can conduct some surveys and questionnaires—online or on paper—to come up with some statistics to tell parents and teachers what people like and do not like. When I say "people", we put them into different categories: parents, school teachers, kids, professors and so on—because if you teach in the university, you also wish to have students of a certain quality and that is very much influenced by the high school education. Thus we also receive a very strong input from universities. It is not easy.



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Minister Chen: As I have said, Taiwan is quite small; from north to south it is easy to meet together within two or three hours. That is why universities professors, when they feel social pressure, will try to find some solution, together with the high school teachers. It is easier to have that association and to get the passion together.

Also, Taiwan society tries to take advantage of the huge pressure resulting from the entry exam. Society already has too much pressure as a result of the entry exam. If there is a good revolution idea, it is easier to release all the pressure (through these associations). I think a lesson for Taiwan is that, although of course it is painful, this way of working gets more support from parents, students and also teachers, so it is easy to take the action on that basis.

Q279 **Emma Hardy:** You talked about how you are teaching skills and knowledge. What skills do you value the most? What are the skills that you want your young people to learn?

Professor Wu: It depends on which age category you are talking about. If you talk about high school, it is very similar to your A levels, but we have senior high, which is three years between the ages of 15 and 18. We categorise the school into four types. The first two are the major types, the general school that we all have and then the vocational schools. The third one is comprehensive and the last one is specialised.

If you want to explore this issue maybe we should focus more on the first two. For the vocational, basically we have this concept of cluster to form a new kind of—not an association—community in which people can interact, and involving not only the teachers but the professors, who come up with good solutions as a reference, as a next step. It is not easy to answer this question in few words.

Minister Chen: I can add to that. The Ministry of Science and Technology is the largest funding system in Taiwan, so all the funding for the academic research here comes from the Ministry. In my Ministry there is one division called “scientific education”, where we have some professors researching how to have a good scientific method for teaching students. All of that research can contribute to the initiative, to get together the ideas. For example, in recent years a lot of teachers got together to learn how to have the so-called flipping classroom, which is a new teaching style that can make students more active than they would be inside the classroom. A lot of teachers get together to learn how to use the ideas and skills of the flipping classroom, so that it is easier to make progress in a lot of different levels of schools. Some teachers come from middle school, some from junior high and some from senior high, and they get together, so it is easier to progress this skills training.

Professor Joung: As a teacher, I think critical thinking is the most important thing. A student cannot just take what he is told; he has to be able to think and to challenge the status quo. To me, that is the most



important skill, regardless of whether he is a high school student or a college student.

Professor Wu: Maybe I find a quick answer to your question. Instead of the 13 years before the college you have here, in Taiwan we have 12 years—six for primary, three for junior high and another three for senior high. We call it a 12-year basic education. It's written in black and white, saying that the main concepts for this basic education: the first is 'taking initiative'; the second is 'engaging in interaction'; and the third is 'seeking the common good', so that is referring to the society. All the details of the curriculum for those 12 years are very much based on these things. This is the new curriculum that we are talking about that we started a few years ago, and this has been checked and rechecked again. When we come back with more details about the curriculum of the different type of schools that I mentioned earlier, we always have to come back to check to see if they meet the three pillars of the 12-year basic education.

Q280 **Trudy Harrison:** Just on primary age teaching, you talk about having initiative and critical thinking. How do you teach that at a primary age, and how do you test whether that teaching has been effective on primary age pupils?

Professor Joung: For me, I would just ask questions rather than having exam-based assessment. I always keep asking, asking, asking, to see if the student really gets this.

Minister Chen: For elementary school teachers, as I have said, we have a society where they try to develop some different kinds of skills for the classroom. In elementary schools we already have a so-called active learning system. We use some personal computers or high-tech learning systems so that the teacher can directly discuss it with different individual students. That is easier for the student, doing this critical thinking or some kind of flipping-style learning.

Q281 **Chair:** You have very good science and maths results in the PISA rankings, but less so for literacy—you are 23rd in the PISA rankings for reading, but you rank fourth in the world for maths and science. What are you doing to improve literacy?

Professor Wu: I think that in some ways that relates to my earlier comment about the overproduction for STEM degrees, because being a medical doctor or an electronics engineer has been the mainstream in Taiwan for several decades already, for good reasons. Now it's really an issue of under-emphasising the importance of the social sciences-related capability. For example, maths is compulsory from year one of the 12 years, so it is four hours per week all the way from year 1 to year 11, because for the last year they get some options. For the natural sciences, we start from year 3, with three hours per week all the way to year 9 (i.e. 15 years old), and then after that they have six hours of natural sciences (equivalent to three hours per week until year 11, which is the



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year 12 in UK). It is compulsory for all girls and boys. Indeed, that is an issue and we are aware of this problem.

Then it becomes another issue, which is what we need for Taiwan. It has come this way, but we know the reason, because of the tradition, because of history. Now for this new trend for the 21st century, we know this is something... That is why for the entry exam we also require the natural science students to take social science as well.

Minister Chen: As you are aware, Asian parents tend to ask their kids to stay focused on their education and learning. We have some observations. For example, we are talking about the industrial revolution, which started in the UK and was then broadcast throughout the whole world. The Asian area is more like a latecomer to the industrial revolution, so parents tend to expect that their kids can use the new system to become active and productive. In Taiwan, all parents ask their kids to stay focused on some subjects for the PISA test. I think the scores are quite good in all Asian countries, but Taiwan's culture means that we are changing a little bit to a multidiscipline approach that is focused not just on exam scores, so there is a different culture change right now.

Dr Chen: Another point is that previously colleges used exam results to test a student's performance, but currently we just ignore the exam base and instead use a project to evaluate them, to encourage them to collaborate with different fields. For example, a computer science student can probably collaborate with other fields, and in this way other skills and specialties can be emphasised.

Q282 **Marion Fellows:** I know that you are in a rush to get away, but could I just ask how you retrain your current workforce? Things change rapidly in industry, so what do you do to retrain the people who are already in one job and need to move to something else?

Minister Chen: It is not easy to retrain teachers for another job, so for teachers, mainly for the senior subjects, we try to adapt more diverse technology when they are improving. For example, when I was Deputy Minister (of Education) we had a programme to select some of our teachers and send them to Austria or Germany to learn the skill or the curriculum for industry 4.0, but staying with the most senior subjects. However, for people who are already in the jobs market we have these kinds of so-called retraining style. That is possible. We have tried to teach them with the so-called secondary skills. In that case we will design a series of curriculums and then the employee can sign in for the curriculum. After that, they get a certificate, so this is employee retraining style, so we have different kinds of style.

Q283 **Marion Fellows:** Does that retraining happen in special schools, or is it done on the job in industry?



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Professor Wu: It is conducted by the Government, so we have these retraining centres, which are national programmes. That is what the Minister is talking about, so it has been there for a long time.

Minister Chen: In Taiwan we have three major retraining centres.

Q284 **Marion Fellows:** I was thinking of my own experience, where we brought people into colleges of further education to do it, but you have practical centres set up nationally. That is interesting.

Minister Chen: Yes.

Q285 **Chair:** Do they do it part-time at these training centres while they are working?

Minister Chen: It depends on different curriculums. Some of them will be condensed courses, so they take leave for three months.

Professor Wu: For people who are working we have part-time programmes. For people who are not working but seeking jobs, we have full-time programmes.

Minister Chen: Some programmes are up to one year.

Q286 **Marion Fellows:** Do people get paid to do this retraining?

Professor Wu: Some of them, yes.

Q287 **Chair:** Finally, clearly you have a lot of science and technology, but how do you encourage students to do STEM subjects? What is the gender balance between men and women doing STEM subjects, and how do you encourage more women to do these subjects?

Professor Wu: Basically, we do not encourage them to do that; we force them to. As I mentioned, they have to do mathematics—no exception—from year 1 all the way to year 11. For the last year before college they have a choice of whether or not to do further maths. For natural science they start in year 3 all the way to the equivalent to your year 12, but our year 11. It is compulsory, including physics, chemistry, biology and earth sciences. So they have to do all these STEM subjects—no exception—if they want to take the exam that I mentioned earlier.

The second question was about gender. I do not have good statistics on the proportion of men and women in STEM jobs, but we do have some statistics about female participation in the jobs market. For example, the current jobs market is 45% female, which shows growth of 5% since 20 years ago—if I remember correctly, 20 years ago it was only 40%. For the PhDs we now have 30% female, compared with 25% 10 years ago. There is growth and we also put a strong emphasis on the balance between the genders. You have probably lately heard about the gender issue in our legislation yuan.



Minister Chen: We are also aware of this balance problem, so from last year we do have the statistical analysis to find out what proportion of men and women are dedicated to different kinds of subjects. With regard to STEM, I mentioned that my Ministry issues (research) projects and we counted the projects to find the ratio. The ratio shows that we are getting fewer women researchers, so last year we had a new initiative. We initiated a programme that allows only women researchers to apply, so we are using some kind of policy to encourage all the (female) researchers; they can spend more effort doing the STEM-related research.

Professor Joung: We also have a programme to help women to do research because, as the Minister has just said, at the beginning the ratio of female to male may be like 30:70 or 40:60. As the age goes by, the female part is decreasing. There are several kinds of issues, maybe pregnancy or something like that, so the programme is intended specifically to help achieve a gender balance.

Dr Chen: We also organise some events for high school students, and we will motivate more females from our department to participate in these events. Usually students have some stereotype about programmers and IT people, which might not be very good, so female students may have some stereotype too. We are organising these event to allow them to understand more and to realise that they could also use software or AI in art, for example, or in others subject they are interested in. That might partially motivate them to join this field.

Q288 **Chair:** Finally, how do you foster a positive culture of behaviour and learning in schools? I understand that your pupils tidy up their classrooms after. What methods do you use to promote a positive culture for behaviour and learning?

Professor Wu: It is really part of everybody's childhood memory that you clean the classroom before you can learn the knowledge. If you do not do it well, you do not have a clean environment. The part where we struggle is with cleaning the bathrooms so, in order to be fair, we have a rotating system so that different classes, for example, clean the bathrooms.

We even conduct the cleaning service in the universities, although for some time it has been criticised. There are still some young people who are willing to clean the university campus, and we issue them with a credit because, as you know, it is a compulsory course for university to have your service hours. Not long ago it was compulsory to clean the campus, but now we have adapted to a more flexible system where you can choose to clean the campus, to do community service for young kids, or to do other things that you think are beneficial to society.

So we stay very flexible about this kind of service—no payment, no reception for knowledge. That is a basic concept, because the teachers



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are very well admired in our community, so the young people need to take care of things in a good way.

Dr Chen: In our department the students have their own space that is only for students. Students will organise an association and they will do the organisation on their own. If they find out that nobody makes you clean the space, it will be very dirty and they will try to think about how to organise good policy to make students take turns cleaning it. We do not force them to do that. We say, "This is your space and you use it, so you want to make it clean." They will think, "Oh, that is our responsibility."

Chair: May I say again what an honour it is to have you all here? It is fascinating to learn about the progressive reforms you are introducing in your country. We again thank not just you, but the ambassador and the distinguished guests. We look forward to maintaining our dialogue. Your evidence will be very helpful when we publish our report in a couple of months' time on the fourth industrial revolution and education in the United Kingdom. Thank you.