

**National Assembly for Wales**  
Enterprise and Business Committee

# Science, Technology, Engineering and Mathematics Skills

September 2014



Cynulliad  
Cenedlaethol  
Cymru

National  
Assembly for  
Wales

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## Enterprise and Business Committee

The Committee was established on 22 June 2011 with a remit to examine legislation and hold the Welsh Government to account by scrutinising its expenditure, administration and policy, encompassing economic development; transport and infrastructure; employment; higher education and skills; and research and development, including technology and science.

### Current Committee membership



**William Graham (Chair)**  
Welsh Conservatives  
South West Wales



**Mick Antoniw**  
Welsh Labour  
Pontypridd



**Byron Davies**  
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Welsh Liberal Democrats  
South Wales Central



**David Rees**  
Welsh Labour  
Aberavon



**Joyce Watson**  
Welsh Labour  
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# Contents

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<b>The Committee's Recommendations</b> .....	5
<b>Foreword</b> .....	7
<b>Introduction to the inquiry</b> .....	9
Background .....	9
Process.....	9
<b>Science for Wales and National Science Academy</b> .....	11
<b>STEM in schools</b> .....	14
Early intervention .....	14
Computing .....	16
Work experience.....	17
Careers advice .....	20
Skills gap in school leavers .....	23
STEM teachers .....	25
<b>STEM in further and higher education</b> .....	29
<b>STEM and the labour market</b> .....	32
<b>Gender and STEM</b> .....	34
<b>Language and STEM</b> .....	40
<b>Annex A - Inquiry terms of reference</b> .....	42
<b>Witnesses</b> .....	43
<b>List of written evidence</b> .....	45



## The Committee's Recommendations

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The Committee's recommendations are listed below in the order that they appear in this report. Please refer to the relevant pages of the report to see the supporting evidence and conclusions. Our recommendations are directed at the Welsh Government unless specified.

**Recommendation 1.** Under the guidance of the Chief Scientific Adviser for Wales, continue to develop a coherent plan for the promotion, monitoring and evaluation of STEM enrichment projects undertaken through the National Science Academy hubs, and involve both the Department for Education and the Department for Economy, Science and Transport in that process. (Page 13)

**Recommendation 2.** Prioritise its investment in early interventions that can enthuse children in STEM and inspire them throughout their entire education, but ensure those interventions are long-term and pan-Wales. (Page 16)

**Recommendation 3.** Respond swiftly to the ICT review report's recommendation to change computing in the curriculum so that Wales can produce the technologists needed by the computing industry in the future. (Page 17)

**Recommendation 4.** Encourage schools to play a more active role in replacing the services previously carried out by Careers Wales, and support them in liaising with employers and organising relevant, timely and meaningful STEM placements for young people. (Page 19)

**Recommendation 5.** Ensure that the revised Welsh Baccalaureate leads to the development of higher-level STEM work experiences similar to the approach taken to providing higher and lower-level apprenticeships. (Page 19)

**Recommendation 6.** Target interventions from year 7 onwards, so that students receive accurate and impartial careers advice before they have to make crucial subject choices, and ensure that advice is provided in person as well as online through a significantly improved Careers Wales website. (Page 23)

**Recommendation 7.** Target Continuous Professional Development (CPD) based on accurate and up-to-date data on where it is most needed, and in particular, support and monitor Estyn's 2013 recommendations that primary schools should provide more training for teachers with weak science subject knowledge. (Page 28)

**Recommendation 8.** Enable all STEM teachers and lecturers to gain relevant experience of working in STEM businesses and industries. (Page 28)

**Recommendation 9.** Develop a clear expectation of what the Welsh Government expects the higher education sector to be delivering for the STEM agenda: in the short term through the Minister's Annual Remit Letter to the Higher Education Funding Council for Wales, and in the longer term as part of the Government's response to the recommendations of the Review of Higher Education Funding and Student Finance Arrangements in Wales, led by Professor Sir Ian Diamond. (Page 31)

**Recommendation 10.** Publish a formal skills audit of supply and demand for STEM skills in Wales and compare that with the projected future needs of a growing and sustainable Welsh economy. (Page 33)

**Recommendation 11.** Based on proven good practice, target more interventions at an early age to encourage girls to achieve their full potential in STEM but sustain those interventions over the long term until there is a gender balance in those subjects. (Page 39)

**Recommendation 12.** Work with STEM employers to develop support structures for providing more flexible and family friendly working environments and support the work of the Chief Scientific Adviser in this area. (Page 39)

**Recommendation 13.** Ensure a joined-up approach so that the Welsh language is mainstreamed in strategies and policies to promote STEM. (Page 41)

**Recommendation 14.** Address the lack of availability of STEM teaching materials in the medium of Welsh. (Page 41)



## Foreword

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1. Science, Technology, Engineering and Mathematics (STEM) skills underpin the knowledge-based economy, and digital skills are becoming increasingly relevant to our everyday lives. The STEM agenda is therefore vitally important for Wales, and will become even more so in future.

“There will be a 122% increase in demand for biological science graduates within the next eight years, a 56% increase for engineering graduates, a 95% increase for mathematical science and computer graduates, a 38% increase for medicine graduates, a 48% increase for physical environment science graduates, and an 80% increase for technology graduates.”<sup>1</sup>

2. Wales therefore needs to strive for excellence in STEM right through the pipeline – from the curriculum and qualifications offered in primary and secondary schools, in colleges and universities, through careers advice and work experience, and into meaningful and sustainable employment.

3. Three and a half years on from our predecessor Committee’s inquiry into the STEM agenda, we appreciate that there has been much activity in the STEM field, but progress has been slow.

4. This is therefore a good time to be revisiting the issue. The Welsh Government has recently responded to the report of the ICT Steering Group, which explored the future of computer science and ICT in schools in Wales. Phase 2 of Professor Graham Donaldson’s independent review of the curriculum and assessment arrangements is underway. Much of the evidence to our inquiry pointed to the need to improve the uptake and quality of STEM within schools, and we hope that progress will be made in this area.

5. However, as several witnesses to our inquiry commented, there is no “magic wand” for addressing the issue: a “long-term fix” is required.<sup>2</sup>

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<sup>1</sup> Careers Wales quoting UK labour market intelligence figures, Record of Proceedings paragraph 153, 4 June 2014

<sup>2</sup> Dr Tom Crick, Record of Proceedings paragraph 321, 4 June 2014

6. Many of the underlying problems stem from the fact that popular perceptions of the STEM disciplines are still quite poor. Cultural stereotypes of “geeky” scientists and “subjects for boys” are alive and well, and regrettably they are embedded from an early age.
7. Fundamentally, we see the need for a seismic shift in culture towards positive, gender-neutral perceptions of STEM. Building STEM “capital” requires the right culture in schools but also within families and society as a whole. The media will have a major role in that, but the Welsh Government too has a key part to play.
8. We would like to see a more strategic and joined-up approach to interventions in the different STEM subjects, based on a greater understanding and evaluation of their impact. Interventions in getting young people interested in STEM, girls especially, and in influencing the key influencers—parents and teachers—need to start as early as possible.
9. We want to see changes in the STEM curriculum to focus on the qualification needs of the young person in their chosen career or learning pathway, not what might be convenient or desirable for the school.
10. We would like to see the provision of impartial, accurate and timely careers advice, which starts before year 9, to help pupils in the transition from years 7 to 9.
11. We want to see a cascade of STEM role models, particularly female role models, at all educational levels and at all stages in their careers.
12. We want to see Continuous Professional Development (CPD) for teachers and lecturers that can build capacity in delivering the STEM agenda from Foundation Phase through to further and higher education.
13. We have come across some excellent initiatives during this inquiry. We want to see those kinds of inspirational projects happening right across Wales.

## Introduction to the inquiry

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### Background

14. In January 2011 the Third Assembly's Enterprise and Learning Committee published its report on The Science, Technology, Engineering and Mathematics (STEM) Agenda. The Committee's inquiry focused on three main themes: the acquisition of STEM skills; the teaching of STEM skills; and the link between education and STEM employers.

15. The aim of our current inquiry was to follow up progress made since the previous Committee published its recommendations. We particularly focused on the take-up of STEM subjects and STEM careers by women. The terms of reference of our inquiry are listed in Annex A.

16. Following its response to the previous Committee's report, the Welsh Government published (March 2012) a new science strategy Science for Wales, followed in May 2013 by the Science for Wales: Delivery Plan. The Welsh Government has also published (September 2012) Science, Technology, Engineering and Mathematics (STEM): Guidance for schools and colleges in Wales which includes guidance on the qualifications needed for a STEM career, and the range of routes to achieving it.

### Process

17. We launched this inquiry in March 2014 with a call for written evidence. We received 16 submissions, listed at the end of this report.

18. We opened our oral evidence sessions with two web-chats<sup>3</sup> with STEM students, who were self-nominated through further and higher education institutions and relevant organisations such as STEM Cymru. We wanted to find out their views on whether enough is being done to encourage young people to study STEM subjects and whether STEM courses equip them with the necessary skills for careers in those fields.

19. We are very grateful to the Assembly's Outreach and Communications team who set up and facilitated the web-chats. It was the first time we had used this technique for collecting evidence and

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<sup>3</sup> A web-chat is an online text-only conversation using a software package

we were impressed with how useful it proved in focusing questions and answers and extracting information from a number of people at the same time.

20. We also took oral evidence from a range of organisations and individuals, listed at the end of this report. Our inquiry culminated in a scrutiny session with the Minister for Education and Skills, the Deputy Minister for Skills and Technology and the Chief Scientific Adviser for Wales.

21. We are grateful to all the people who contributed evidence and we trust that our recommendations will help the Welsh Government and its partners in taking forward this important agenda.

## **Science for Wales and National Science Academy**

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22. One of the main initiatives under the Welsh Government’s Science for Wales strategy is the Sêr Cymru programme. Working with universities and the Higher Education Funding Council for Wales (HEFCW), the Welsh Government has provided funding for new academic ‘stars’ (‘sêr’) with supporting teams, equipment and a programme of pooling activity across Welsh university departments – National Research Networks. The Welsh Government has committed up to £50 million to the Sêr Cymru programme to enhance and build upon the research capability in Wales.

23. The Sêr Cymru initiative was warmly applauded by Higher Education Wales:

“It was bold, it was big, it challenged us to do things that we would not be doing on our own.”<sup>4</sup>

24. HEFCW’s written evidence stated that Science for Wales has had a positive impact on STEM skills in Wales but that outreach work needs to be better coordinated through the National Science Academy (NSA).<sup>5</sup>

25. The NSA is the Welsh Government’s main vehicle for encouraging greater participation in STEM. It was established in 2010 to bring direction and coordination to STEM outreach activities and is a collaboration between five partner “hubs” with STEM interests: the Centre for Alternative Technology Machynlleth, the National Botanic Garden of Wales, Techniquest Cardiff,<sup>6</sup> Techniquest Glyndwr and the Wales Institute of Mathematical and Computational Sciences.<sup>7</sup> The NSA Grant Scheme provides discretionary financial support for the delivery of STEM engagement and enrichment activities.

26. The Welsh Government website states that the NSA hubs meet regularly and advise the Chief Scientific Adviser for Wales on STEM activity.

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<sup>4</sup> Record of Proceedings paragraph 11, 4 June 2014

<sup>5</sup> HEFCW written evidence page 17

<sup>6</sup> Techniquest is an educational charity with a Wales-wide mission to engage people in science

<sup>7</sup> WIMCS is a partnership of the five universities of Aberystwyth, Bangor, Cardiff, Swansea and South Wales

27. A Task and Finish group of the Science Advisory Council for Wales recently reported on the NSA. Its report, Inquiry into STEM engagement and education enrichment activity (published 14 April 2014) concluded that there was confusion about the purpose and objectives of the hubs, the resources available to support their work, and how advice and good practice from the hubs was being shared or fed back into the development of a strategy for the NSA.

28. In its written evidence to our inquiry, the Higher Education Funding Council for Wales (HEFCW) said that although HEFCW was represented at the National Science Academy hub meetings, they have not taken place for some time. HEFCW therefore questioned whether the Academy was fulfilling its functions as set out in the Science for Wales strategy and whether there was a lack of strategic approach to STEM outreach and a failure to maximise the opportunities offered by the strategy.<sup>8</sup>

29. We would echo those concerns. When we took oral evidence from the individual NSA hubs on 14 May we were concerned to hear that they had not met since September 2012, although a meeting was scheduled for 23 May.<sup>9</sup> The witnesses expressed concern at the lack of strategy for the NSA, lack of coordination, and lack of monitoring and evaluation of initiatives funded through the NSA hubs. This was put down to a variety of factors, but chiefly the illness and retirement of the previous Chief Scientific Adviser for Wales and an absence of drive and direction from the Welsh Government. The important point was made that the NSA, which is based within the Welsh Government's Economy, Science and Technology department, should also have involvement from the Department for Education and Skills.

30. We heard evidence from Techniquist and from Dr Tom Crick, Senior Lecturer in Computing Science at Cardiff Metropolitan University, about the positive impacts of the NSA Grant Scheme in funding work to help change perceptions about STEM.

31. Written evidence from the Institute of Physics, however, stated that the "allocation of funding [through the NSA] has not been

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<sup>8</sup> HEFCW written evidence page 2

<sup>9</sup> Record of Proceedings paragraphs 4-21, 14 May 2014

sufficiently prioritised to address the most pressing issues in education and skills”.<sup>10</sup>

32. The Royal Society of Chemistry highlighted the need to provide a clearer picture of STEM enrichment activities and gaps in current provision.<sup>11</sup>

33. When we challenged the Welsh Government on these points, the Chief Scientific Adviser for Wales told us that she was reviewing “where we are, what seems to be working well and what may not be working well, to see how we can go forward”, and that she was also taking “a broader view with regard to what we are trying to achieve with the NSA, which is, really, to enthuse”.<sup>12</sup> The Welsh Government’s written evidence also outlined a new lease of life for the NSA.<sup>13</sup>

34. We believe there is a useful role for the NSA to play in future in reinvigorating STEM participation in Wales and specifically in developing a coherent policy for coordinating and evaluating activity by the constituent hubs. The collection of gender-segregated data for STEM-related activity should also be a priority. We therefore welcome the Welsh Government’s intentions to regain momentum in this area.

### **Recommendation 1: the Welsh Government should**

**Under the guidance of the Chief Scientific Adviser for Wales, continue to develop a coherent plan for the promotion, monitoring and evaluation of STEM enrichment projects undertaken through the National Science Academy hubs, and involve both the Department for Education and the Department for Economy, Science and Transport in that process.**

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<sup>10</sup> Institute of Physics written evidence page 2

<sup>11</sup> Royal Society of Chemistry written evidence page 3

<sup>12</sup> Record of Proceedings paragraph 89, 12 June 2014

<sup>13</sup> Welsh Government written evidence page 3

## STEM in schools

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35. In our web-chats with higher education students we gained a basic understanding of some of the issues affecting young people's decisions to study and work in STEM fields.

36. We heard that it tended to be love of the subject that had led them to choose to study STEM more than the prospects of a job in the sector: "space science just really blew my mind".<sup>14</sup>

37. However, there seemed to be problems surrounding the perception of STEM subjects. We heard that "a lot of people perceive STEM subjects as hard,"<sup>15</sup> or "boring and geeky".<sup>16</sup>

38. We were also told that "people consider physics and maths to be subjects for boys",<sup>17</sup> although all the female web-chat students told us that their schools were not biased in the encouragement they gave:

"We were encouraged to do what we liked and what we were good at, regardless of gender".<sup>18</sup>

39. Parents appeared to have a strong influence on students' decisions to pursue STEM studies, and also teachers:

"Good teachers love their subject and they can inspire people."<sup>19</sup>

### Early intervention

40. In its written evidence the Wales Institute of Mathematical and Computational Sciences stated that there was a clear need to engage with students in the years prior to GCSE to encourage the take-up of

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<sup>14</sup> Chris Lorch, Planetary and Space Physics, Aberystwyth University, web-chat 1, 30 April 2014

<sup>15</sup> Ryan Myles-Roberts, Masters Mathematics, Aberystwyth University, web-chat 1, 30 April 2014

<sup>16</sup> Catherine Louise Jones, Biomedical Science, Aston University, web-chat 1, 30 April 2014

<sup>17</sup> Aled Illtud, Physics, Aberystwyth University, web-chat 1, 30 April 2014

<sup>18</sup> Elen Pierce Everett, Masters Biomedical Research, Cardiff University web-chat 2, 30 April 2014

<sup>19</sup> Ryan Myles-Roberts, Masters Mathematics, Aberystwyth University, web-chat 1, 30 April 2014



STEM, and that the challenge was underscored by Wales's relatively poor PISA results, particularly in maths.<sup>20</sup>

41. Chwarae Teg<sup>21</sup> suggested intervention should be even earlier, with children being encouraged to engage with STEM subjects from the Foundation Phase onwards,<sup>22</sup> a view shared by Wendy Sadler, Schools Liaison Officer at Cardiff University's School of Physics and Astronomy, and by Techniquest.

42. This view was also expressed during our web-chats with higher education students. One of the students told us:

"They need to inspire children and young people into STEM through an innovative, practical and thought-provoking curriculum, starting as soon as, or even before, they get to school."<sup>23</sup>

43. The students suggested that inspirational guest speakers should be used throughout the education system, from primary through to degree level.

44. The Field Studies Council referred to the need to maintain students' positive attitudes to science through all key stages, and especially between primary level and GCSE.<sup>24</sup>

45. We were therefore interested to hear from Dr Crick about Technocamps, a project based at Swansea University, Aberystwyth University, Bangor University and the University of South Wales which receives £6million over three years from the European Structural Fund/Welsh Government:

"It has had, frankly, a profound effect on addressing or changing attitudes to computing for the ages of 11 to 19 in the convergence areas of Wales. I am just saddened that it is not a pan-Wales project, because it is truly needed to address the problems in Wales. There has been no clarification about the end of funding after the end of September. It has probably

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<sup>20</sup> WIMCS written evidence page 2

<sup>21</sup> Chwarae Teg is a charity that works with women to broaden horizons and build confidence and skills

<sup>22</sup> Chwarae Teg written evidence paragraph 2.1

<sup>23</sup> Ryan Myles-Roberts, Masters Mathematics, Aberystwyth University, web-chat 1, 30 April 2014

<sup>24</sup> Field Studies Council written evidence paragraph 18

been one of the most successful ESF projects, I would say, and it is addressing both curriculum-type stuff—so, it is changing perceptions of the discipline, and also informing the potential for studying these subjects at school—and also addressing broader things like NEETs and socioeconomically deprived areas. It is changing aspirations, which is exactly what the project was aiming to do.”<sup>25</sup>

46. During our scrutiny session with the Welsh Government the Minister for Education and Skills agreed that his “instinctive feeling” was that students should be engaged in STEM “as early as possible”. The Chief Scientific Adviser for Wales also agreed, and added that it was important for STEM to be cleverly packaged at that age.<sup>26</sup>

47. The Deputy Minister for Skills and Technology told us:

“We have the enterprise troopers that encourage creative thinking and enterprise, we have skills competitions, which we are performing incredibly well at, and we have got the STEM ambassadors and the apprentice ambassadors. So, you continually make sure that there is awareness of careers and of the world of work throughout education, but that, at critical times, you are offering cast-iron, sound advice and guidance that is impartial and based around labour market intelligence and future jobs growth trends.”<sup>27</sup>

## **Recommendation 2: the Welsh Government should**

**Prioritise its investment in early interventions that can enthuse children in STEM and inspire them throughout their entire education, but ensure those interventions are long-term and pan-Wales.**

### **Computing**

48. We have not homed in on any particular STEM subject in this inquiry, but we were concerned to hear from Dr Tom Crick that computing science “is overlooked within the broader STEM agenda”, and that learners were being taught to be users of technology rather than being taught computer science. Dr Crick, who co-chaired the Welsh Government’s review of the ICT curriculum last year, expressed

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<sup>25</sup> Record of Proceedings paragraph 300, 4 June 2014

<sup>26</sup> Record of Proceedings paragraphs 10-11, 12 June 2014

<sup>27</sup> Record of Proceedings paragraph 20, 12 June 2014

“significant concern about the number of people taking the qualifications and the perceptions of the discipline and how important it is educationally and economically”.<sup>28</sup> He said the number of students taking A level computing (as opposed to ICT) had dropped significantly since 2003 when the disciplines were split.

49. The ICT review report recommended curriculum and qualifications reform: the creation of a new subject called computing and separation of the digital literacy aspects for embedding across the curriculum, as for literacy and numeracy. Dr Crick told us the ICT review report was “positively received across the UK”, and although the Welsh Government had addressed the recommendations regarding digital literacy, he was disappointed with its response to the educational and economic importance of developing computing skills, which he referred to as “deeply concerning”.<sup>29</sup>

50. When we scrutinised the Minister for Education and Skills on this issue, he told us he was not prepared to make “hasty decisions” about changing computing in the curriculum.<sup>30</sup>

51. We appreciate that the Welsh Government needs to make the right decisions and have the right infrastructure in place before changing computing in the curriculum. Yet we also see the need to make changes in sufficient time to prevent Wales from losing a whole cohort of students from one of the major growth areas for future employment.

### **Recommendation 3: the Welsh Government should**

**Respond swiftly to the ICT review report’s recommendation to change computing in the curriculum so that Wales can produce the technologists needed by the computing industry in the future.**

#### **Work experience**

52. Since the previous Enterprise and Learning Committee undertook its inquiry into the STEM agenda, Careers Wales has changed its remit. It is now a wholly owned subsidiary of the Welsh Government with a remit set by the Minister for Education and Skills to provide an all-age, independent, bilingual careers information advice and guidance service. Careers Wales no longer supports the setting up of work

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<sup>28</sup> Record of Proceedings paragraph 286, 4 June 2014

<sup>29</sup> Record of Proceedings paragraphs 290-296, 4 June 2014

<sup>30</sup> Record of Proceedings paragraph 62, 12 June 2014

experience placements, but it does maintain the national work experience database for students in years 10, 11 and 12. This enables young people to search for places available in their local area and to make their choices online.

53. Our web-chats with higher education students revealed that their experience with finding work experience had been problematic. They appeared to us to have been left largely to plough their own furrow in finding relevant or meaningful opportunities while at school:

“It was really easy to get placements for teaching or shop assistants but not for medicine and dentistry [...] Every piece of relevant work experience I managed to get was organised by me and done in my own time.”<sup>31</sup>

54. The Construction Industry Training Board (CITB) told us that because work experience meets the needs of schools rather than industry many employers have been discouraged from offering places. It suggested that:

“Employers need to work more closely with Careers Wales to develop something that is more suitable for our particular industry, and is not such a broad-brush approach to work experience.”<sup>32</sup>

55. When we spoke to Careers Wales we were told that “work experience placement should meet the needs of the individual young person” rather than schools or businesses. It confirmed the change to its remit and informed us that its role was now to “facilitate links between employers and schools”.<sup>33</sup> We were told it believed schools had the responsibility to secure work experience, but it was:

“Very keen to move away from a sort of sheep-dip approach, where all young people go out to a placement and have a week’s experience that is not necessarily going to give them a better understanding of the world of work or help them to make some informed career decisions.”<sup>34</sup>

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<sup>31</sup> Jenna Keenan, Dentistry student, Cardiff University, web-chat 2, 30 April 2014

<sup>32</sup> Record of Proceedings paragraph 233, 14 May 2014

<sup>33</sup> Record of Proceedings paragraphs 102 and 126, 4 June 2014

<sup>34</sup> Record of Proceedings paragraph 103, 4 June 2014

56. Careers Wales also confirmed that work placements were more difficult to secure in smaller companies and in some rural parts of Wales.<sup>35</sup> It was working with the Welsh Government on a project to improve the adequacy and sufficiency of work experience placements for young people and to be “more lateral in our thinking in terms of work experience”.

57. The Deputy Minister for Skills and Technology reaffirmed for us that “the enhanced employer engagement programme will be far more nimble and intelligent”.<sup>36</sup> He also explained that the Welsh Government was considering the most appropriate way of communicating with young people:

“Facebook is becoming antiquated. That is what young people are telling us. How will they be seeking advice, news and information by 2020? So, we will be meeting with experts in communications and computing to make sure that the architecture that we will put in place in the coming months, and over the course of the next year, will be robust enough to last for several cohorts of young people.”<sup>37</sup>

58. We believe that work placements are critical for giving STEM students an insight into work and careers and we trust that the revised Welsh Baccalaureate qualification for implementation in 2015 and its emphasis on skills development will provide the opportunity to strengthen the delivery of the careers and the world of work curriculum.

#### **Recommendations 4 and 5: the Welsh Government should**

**Encourage schools to play a more active role in replacing the services previously carried out by Careers Wales, and support them in liaising with employers and organising relevant, timely and meaningful STEM placements for young people.**

**Ensure that the revised Welsh Baccalaureate leads to the development of higher-level STEM work experiences similar to the approach taken to providing higher and lower-level apprenticeships.**

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<sup>35</sup> Record of Proceedings paragraph 111, 4 June 2014

<sup>36</sup> Record of Proceedings paragraph 22, 12 June 2014

<sup>37</sup> Record of Proceedings paragraph 26, 12 June 2014

## Careers advice

59. During our web-chats with students, one of the main issues to emerge was the quality and timeliness of careers advice. There was an emphasis on the good advice received from teachers, but considerable criticism of the advice received from Careers Wales. As one of the web-chat students told us, there has to be a good synergy between both parties:

“I saw a career adviser once when I was in Year 9 and then never again. I know in other schools it is run differently, but you have much more day-to-day contact with teachers and they play a vital role in educating girls about STEM subjects.”<sup>38</sup>

60. It is important that young people are fully informed about potential career opportunities. One of the web-chat students told us that she was never aware she could pursue a research career. Another student told us:

“We were told that STEM subjects were pretty much either medicine or finance. I was never really told what other careers maths or physics could bring.”<sup>39</sup>

61. Another one of the students told us that it was important for young people to understand that they could achieve careers in medicine and dentistry through routes other than the traditional dedicated courses:

“My school told me that because I did not get into dentistry first time I should give up hope but I did a biomedical science degree and am now doing dentistry.”<sup>40</sup>

62. In its written evidence, CollegesWales stated that take-up of vocational subjects in STEM areas needed to be promoted more effectively in schools:

“It is crucial that a high-status vocational learning route encompassing STEM subjects, apprenticeships and higher technical qualifications including a degree is as well understood by learners, teachers, lecturers and parents as the

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<sup>38</sup> Zoe Morgan, Medicine student, Cardiff University, web-chat 2, 30 April 2014

<sup>39</sup> Rebecca Hanley, Masters Mathematics student, Exeter University, web-chat 2, 30 April 2014

<sup>40</sup> Jenna Keenan, Dentistry student, Cardiff University, web-chat 2, 30 April 2014

GCSE-A level-degree route. Current research has shown that young people are not aware of the choices available to them at 14.”<sup>41</sup>

63. CollegesWales told us in oral evidence that it was “still concerned that impartial advice and guidance is not coming through at the right stage” and that schools were mainly responsible.<sup>42</sup>

64. CITB commented on the need to change perceptions that construction was a low-skilled profession:

“The industry and industry bodies need to work more closely with careers advisers and perhaps a CPD programme for careers advisers, because it is their mindsets and the mindsets of parents that we need to change, perhaps to educate them through a series of awareness-raising programmes or modules about the industry.”<sup>43</sup>

65. When we spoke to Careers Wales we were told that careers education provided within schools and the services that Careers Wales provides “seem to get merged” and that there was a need to make “a clear distinction between the two”.<sup>44</sup>

66. Careers Wales told us its advice was “impartial and independent”, that it did not promote any individual sector (such as STEM) and that it focused on year 9 and year 11 students in schools:

“Given the limited resources we have, we think that it makes sense to try to target our interventions at those periods when young people are making those important decisions that will affect the rest of their lives.”<sup>45</sup>

67. However, Careers Wales acknowledged that:

“In terms of the evidence, I would cite the recent Estyn inspection on the learner support arrangements within schools, which highlighted some very significant deficiencies in terms of the career education that young people are given at that age. The report also cited examples of individuals who took the

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<sup>41</sup> CollegesWales written evidence paragraph 4

<sup>42</sup> Record of Proceedings paragraphs 194-199, 4 June 2014

<sup>43</sup> Record of Proceedings paragraph 242, 14 May 2014

<sup>44</sup> Record of Proceedings paragraph 96, 4 June 2014

<sup>45</sup> Record of Proceedings paragraph 129, 4 June 2014

wrong decisions, ill-informed decisions, which then prevented their options at a later stage.”<sup>46</sup>

68. Careers Wales told us it was working with the new strategic forum for career development chaired by the Deputy Minister for Skills and Technology, to clarify respective roles and responsibilities because “there is a lot of confusion”. It was also working “to review our entire online presence” to “present it in a more up-to-date and user-friendly way that better meets the needs of young people”.<sup>47</sup>

69. It was therefore significant to hear from CollegesWales that:

“We cannot rely on web-based information. Invariably, due to lack of resources, we now find that it is those who are probably at risk of being not in education, employment or training who have the priority and the norm—the majority—is not dealt with and relies upon web-based information.

“I also feel that year 9 is too late; year 11 is definitely too late, because decisions have been made that will affect their performance anyway. We need to start before year 9, to help in the transition from year 7 to 9. That is the critical period in my opinion, but we need much more resource to be added to that area.”<sup>48</sup>

70. When we scrutinised the Welsh Government on these issues, the Deputy Minister for Skills and Technology told us:

“The role of providing impartial guidance lies with Careers Wales. The role of providing awareness, if you like, and advice on careers and the world of work, fundamentally lies with the school. There is anecdotal evidence—you have identified it this morning—that some schools are not being as responsible as others. What I would say, though, is that I have got no problem in advice being based around labour market information that is sensitive to local employment and economic prospects. I think that is only fair and right, and that is something that Careers

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<sup>46</sup> Record of Proceedings paragraph 131, 4 June 2014

<sup>47</sup> Record of Proceedings paragraphs 131-137, 4 June 2014

<sup>48</sup> Record of Proceedings paragraph 228, 4 June 2014



Wales is looking carefully at with the new website, which will go live by the end of the year.”<sup>49</sup>

71. The Deputy Minister also confirmed he was in favour of both Careers Wales and teachers being more proactive to ensure that year 9 students make the right choices for their future career paths. He stated that the enhanced employer engagement programme would expose teachers more to the world of business, so that their advice to students can be based on experience as well as assumption. Careers Wales would be focusing more on year 9 to ensure that the right guidance is offered.<sup>50</sup>

### **Recommendation 6: the Welsh Government should**

**Target interventions from year 7 onwards, so that students receive accurate and impartial careers advice before they have to make crucial subject choices, and ensure that advice is provided in person as well as online through a significantly improved Careers Wales website.**

### **Skills gap in school leavers**

72. The Wales Institute of Mathematical and Computational Sciences told us that “skills in English and presentational skills are at least as important as numeracy skills in mathematics, and we are missing them.”<sup>51</sup> The criticism was levelled lower down the education system at secondary schools.

73. The Construction Industry Training Board (CITB) was also critical of “failure” lower down the education system and said it was “wasteful” for employers, further and higher education “to be picking up the pieces”.<sup>52</sup>

74. CITB recommended greater scrutiny of the primary sector regarding STEM subjects and basic skills transition in general, to bring it in line with scrutiny of secondary education. It believed that Estyn has been “ineffective” in its inspection role and that an independent task force led by industry should be formed to conduct an inquiry.<sup>53</sup>

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<sup>49</sup> Record of Proceedings paragraph 16, 12 June 2014

<sup>50</sup> Record of Proceedings paragraphs 35-36, 4 June 2014

<sup>51</sup> Record of Proceedings paragraph 74, 14 May 2014

<sup>52</sup> CITB written evidence page 1

<sup>53</sup> CITB written evidence page 1

75. Higher Education Wales was highly critical of the “poverty of ambition in some schools”:

“In some schools you cannot even do full syllabuses in physics, chemistry and biology for GCSE. That is a total poverty of ambition because if you have only done a double GCSE, you start doing A-levels at a huge disadvantage and you have a huge leap to take in order to catch up with better-prepared students, and in a modular system, you just do not have time to catch up. So, you are handicapping your young people right from the start. Not being able to provide double mathematics at A-level is criminal and many schools in Wales, I am afraid, still cannot do that.”<sup>54</sup>

76. CollegesWales commented:

“We have to ask the question: what qualifications are offered in school for what purpose? Is it for the purpose of the young person or for the school? If we want the right pupil to move into the STEM area, it has to be [...] qualification-led for the pupil, which is not often the best case for the school.”<sup>55</sup>

77. CollegesWales further told us “there is lots of evidence that there are some serious deficiencies in levels of literacy and numeracy [...] for entrants into colleges at 16, or indeed 17” and that this was a “major issue” for colleges, although there were signs that the situation was improving. Still, the extent to which colleges were having to provide a remedial service was:

“Impacting on our ability to deliver the core vocational requirements that employers seek from us. We are treading a very thin line here in terms of maintaining our credibility and status in terms of the vocational skills required by an employer, while also putting the remedial requirements back into the young people.”<sup>56</sup>

78. Professor Niels Jacob, Head of the Mathematics Department, Swansea University, Wales Institute of Mathematical and Computational

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<sup>54</sup> Record of Proceedings paragraph 42, 4 June 2014

<sup>55</sup> Record of Proceedings paragraph 217, 4 June 2014

<sup>56</sup> Record of Proceedings paragraphs 212-213, 4 June 2014

Sciences, also expressed concern with the level of STEM skills of current school leavers.<sup>57</sup>

79. Wendy Sadler told us:

“Although students have achieved the requirements to get in to do physics, it is my experience particularly that they lack the mathematical skills. Perhaps they do not understand that physics is inherently a mathematical subject, which seems obvious to physicists, but which may not be coming through in the school system. More importantly, I think that it is a change in the way of thinking in terms of how they are learning. At schools, they are possibly learning about how to pass exams, and not learning critical thinking skills.”<sup>58</sup>

80. Professor Andy Evans, Institute Director at the Department of Mathematics and Physics at Aberystwyth University, was more positive about students’ abilities and attitudes to learning:

“The numbers that have come through to study maths and physics since 2009 have doubled, and we have not seen a significant drop in the quality of the students that we create at the other end of the process. I believe that we should congratulate the students for the work that they have done.”<sup>59</sup>

81. We are concerned at the comments expressed about learners and school leavers lacking basic skills, and we urge the Minister to redress this in his priorities for driving up standards of literacy and numeracy.

### **STEM teachers**

82. Chwarae Teg’s written evidence referred to Estyn findings that only about half of primary teachers have a clear vision for developing science in their schools.<sup>60</sup>

83. The Institute of Physics written evidence suggested that there were recruitment and retention issues with physics teachers in Wales.<sup>61</sup> We heard from Wendy Sadler that 40 per cent of teachers in Wales teaching physics do not have a physics background themselves:

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<sup>57</sup> Record of Proceedings paragraph 74, 14 May 2014

<sup>58</sup> Record of Proceedings paragraph 37, 4 June 2014

<sup>59</sup> Record of Proceedings paragraph 38, 4 June 2014

<sup>60</sup> Chwarae Teg written evidence paragraph 2.1

<sup>61</sup> Institute of Physics written evidence page 4

“They are following the curriculum, but if the curriculum itself is not very exciting or engaging, it is not going to switch many people on to physics, and the biology teachers are barely managing to cover all their subjects.”<sup>62</sup>

84. Techniquist also referred to the fact that many physics teachers in schools are not physicists:

“There is a real danger that people who are learning at the moment are not being taught by people who have that keenness and excitement in the subject, but also they do not have the opportunity [...] to be able to do CPD.”<sup>63</sup>

85. CITB expressed concern that the introduction of an additional maths GCSE could lead to a shortage of specialist and semi-specialist teachers (a point also made by the Wales Institute of Mathematical and Computational Sciences).<sup>64</sup> CITB argued this was a particular problem in taking away resources for lower ability students and reducing support for potential apprentices in the lower academic cohort.<sup>65</sup>

86. A number of those giving evidence therefore highlighted a shortage of adequately trained secondary school teachers in some STEM subjects. The Table below shows the percentage of registered secondary school teachers who are teaching STEM subjects but are not trained in that subject:

**Percentage of teachers registered with the GTCW not trained in subject taught**

	March 2012	March 2013	March 2014
<b>Foundation subjects</b>			
Design and Technology	14.7	15.3	15.8
Information Technology	55.2	55.4	56.4
<b>Core subjects</b>			
Biology	32.5	33.9	37.0
Chemistry	45.2	44.9	44.7
Mathematics	15.4	15.2	16.1
Physics	49.1	50.0	50.9
Science	60.4	60.7	63.2

<sup>62</sup> Record of Proceedings paragraph 46, 4 June 2014

<sup>63</sup> Record of Proceedings paragraph 68, 14 May 2014

<sup>64</sup> Record of Proceedings paragraph 70, 14 May 2014

<sup>65</sup> CITB written evidence page 2

**Non-curriculum subject**

Engineering	87.5	88.9	90.0
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Source: General Teaching Council for Wales Annual Statistics Digest 2014

Note: Core subjects – in the case of those teachers trained to teach subjects in the sciences, there is a noticeable transferability in teaching different subjects within these broad groups. For example, a teacher trained in Biology may also teach Chemistry, Physics or General Science

87. Wendy Sadler thought that much of the answer lay in CPD for teachers. The importance of CPD was also raised by the Royal Society of Chemistry.<sup>66</sup>

88. The Construction Industry Training Board suggested that following changes to Careers Wales there has been a loss of purpose and focus to the Careers Wales Education Business Partnerships.<sup>67</sup> These partnerships develop and maintain links between employers, schools and colleges, to raise young people's standard of achievement, improve motivation and help them plan and prepare for working life, as well as developing a sense of entrepreneurship.

89. The National Botanic Garden of Wales made a similar point:

“There used to be support through Careers Wales and through the education and business partnership for funding for teachers so that the cover could be paid in the school for the teacher to come out. That has all disappeared over the last couple of years, so we have seen quite a significant drop in the number of teachers being able to come out of school.”<sup>68</sup>

90. Techniquet's written evidence noted that in Estyn's 2013 report on science in key stages 2 and 3 it was recommended that local authorities should provide primary and secondary schools with more opportunities for CPD on science teaching and learning and that primary schools should provide training for teachers with weak science subject knowledge.<sup>69</sup> Techniquet questioned whether this action could

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<sup>66</sup> Royal Society of Chemistry written evidence page 3

<sup>67</sup> CITB written evidence page 2

<sup>68</sup> Record of Proceedings paragraph 71, 14 May 2014

<sup>69</sup> Techniquet written evidence page 3

be achieved given that the provision for science CPD in Wales has reduced in recent years owing to changes in the main organisations that provided this form of teacher support (local authorities and the General Teaching Council for Wales).

91. In oral evidence, Techniquet further illustrated that there was no cover to enable teachers to attend CPD courses, and that there were no longer any science advisers within local authorities. However, Techniquet believed it was possible to redress this with the appropriate CPD:

“As soon as you have the right training, you are confident about it and then you can become passionate about it as well. That is what we have seen when we have done CPD.”<sup>70</sup>

92. During our web-chats with students we were told that “schools could do with teachers having more experiences in actual fields such as industry”.<sup>71</sup>

93. When we scrutinised the Minister on CPD for teachers he told us that the Welsh Government was committed to providing “world class CPD for each and every teacher” in Wales.<sup>72</sup>

94. We understand that the Welsh Government accepted recommendations relating to CPD made by Estyn in its report Science in key stages 2 and 3 published in June 2013.

**Recommendations 7 and 8: the Welsh Government should Target Continuous Professional Development (CPD) based on accurate and up-to-date data on where it is most needed, and in particular, support and monitor Estyn’s 2013 recommendations that primary schools should provide more training for teachers with weak science subject knowledge.**

**Enable all STEM teachers and lecturers to gain relevant experience of working in STEM businesses and industries.**

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<sup>70</sup> Record of Proceedings paragraph 80, 14 May 2014

<sup>71</sup> Benjamin Williams, BTEC Electronic Engineering student, Coleg Sir Gâr, web-chat 1, 30 April 2014

<sup>72</sup> Record of Proceedings paragraph 8, 12 June 2014

## STEM in further and higher education

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95. CollegesWales referred to the issue of capital funding for STEM in further education:

“We have introduced new learning programmes from September and those tariffs will be different between arts and humanities subjects and STEM subjects. I think what is particularly notable is the need for and the cost of investing in laboratories and engineering facilities. Colleges obviously need proper capital investment to keep those going but also to refresh those facilities.”<sup>73</sup>

96. The Higher Education Funding Council for Wales (HEFCW) has previously provided additional support to institutions providing Welsh Government priority subjects (such as science, maths or modern foreign languages) or expensive subjects such as medicine, dentistry and conservatoire provision (the subject premium). A number of those submitting evidence to the inquiry suggested that changes to the funding regime would have negative consequences for STEM in the higher education sector.

97. In its written evidence, HEFCW argued that the funding changes now created an “in-built economic disincentive” to offering more expensive subjects such as STEM.<sup>74</sup> Concerns about the higher costs associated with STEM subjects were also raised by Cardiff University and by Professor Mike Phillips of University of Wales Trinity St David.<sup>75</sup>

98. Aberystwyth University’s written evidence expressed concern about the “long-term and increasing funding gap between Wales and the rest of the UK in HE funding, especially in STEM subjects”. It stated that some of the challenges included lower subject premia for undergraduate students and lower capital investment.<sup>76</sup>

99. Higher Education Wales referred to the “mixed messages” of, on the one hand, having to promote STEM under the Science for Wales strategy, and then being “incentivised to switch away from high-cost subjects—in other words, laboratory-based and engineering subjects—

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<sup>73</sup> Record of Proceedings paragraph 235, 4 June 2014

<sup>74</sup> HEFCW written evidence page 8

<sup>75</sup> Prof Mike Phillips written evidence; Cardiff University written evidence section 1

<sup>76</sup> Institute of Mathematics, Physics and Computer Science, Aberystwyth University written evidence page 1

to lower-cost subjects”. We were told that universities were being “creative” however in accessing funds from other sources and would “not be put off course, but that does not mean that, in a few years’ time, we will not have some financial crises”.<sup>77</sup>

100. In terms of the extent of the funding gap for STEM subjects, Higher Education Wales estimated that it would cost in the region of £10,000 to teach engineering and laboratory science per student compared with the £7,500 that universities receive (£9,000 minus the £1,500 that HEFCW stipulates for spending on widening access and promoting higher education).<sup>78</sup>

101. Higher Education Wales also expressed concern about postgraduate study in STEM:

“There is a problem at the postgraduate level across the UK. The new fees structures are making it very difficult to get funding for postgraduate courses. There is nervousness about debt. The numbers doing many postgraduate courses are declining and industry is telling us that it wants far more people, but it is the postgraduate courses that are the big differentiator now and that is going to be a major issue over the next few years. One of the sad things to me is that we are spending so much time worrying about undergraduate fees, when, to me, in terms of the future economy, the real issue is going on to higher level skills through Masters and doctorates of engineering courses and so on.”<sup>79</sup>

102. When we later scrutinised the Welsh Government on this issue, the Chief Scientific Adviser for Wales stated that it was “important to have a strong focus on STEM in higher education”, that she had made those representations and she was putting together evidence to show where Wales stands in terms of research scientists:

“HEIs are aware that if they want to achieve their ambitions of being research-active universities and of being universities that are climbing up the league tables, which are very important, then STEM must be at the heart of this.”<sup>80</sup>

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<sup>77</sup> Record of Proceedings paragraph 12, 4 June 2014

<sup>78</sup> Record of Proceedings paragraph 21, 4 June 2014

<sup>79</sup> Record of Proceedings paragraph 58, 4 June 2014

<sup>80</sup> Record of Proceedings paragraphs 52-53, 12 June 2014



103. In the Welsh Government's written evidence it stated that:

“Our 2012 HE reforms have put the HE sector in a much stronger position to invest in STEM provision. Latest forecasts suggest that the new funding regime will contribute an additional £200m in income to the sector during the lifetime of this Government, when compared to the previous funding formula.”<sup>81</sup>

104. We are concerned that in changing the funding formula the Welsh Government has removed the “carrots” for higher education institutions to invest in STEM but has no “sticks” in place to influence their agenda. We would like to see stronger leadership from the Government in supporting STEM in higher education, and the Minister hinted that the Higher Education Wales Bill, which is currently progressing through the Assembly, may be the opportunity for having “a much more connected strategic conversation about the needs of Wales vis-à-vis what HEIs get up to and what they prioritise and where they decide their resources go”.<sup>82</sup>

#### **Recommendation 9: the Welsh Government should**

**Develop a clear expectation of what the Welsh Government expects the higher education sector to be delivering for the STEM agenda: in the short term through the Minister's Annual Remit Letter to the Higher Education Funding Council for Wales, and in the longer term as part of the Government's response to the recommendations of the Review of Higher Education Funding and Student Finance Arrangements in Wales, led by Professor Sir Ian Diamond.**

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<sup>81</sup> Welsh Government written evidence page 3

<sup>82</sup> Record of Proceedings paragraph 59, 12 June 2014

## STEM and the labour market

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105. The previous Committee's inquiry into STEM in 2011 found that Wales faced a skills shortage in STEM areas that were key to the Welsh economy, such as computing and technology.

106. That view was repeated by Dr Tom Crick:

“There is probably a lack of those types of careers in Wales. That is the push-pull problem, in the sense that we want to attract high-value industry to Wales. We probably do not have the skilled graduate workforce to support it, but the industry is not here, so the workforce is going to go somewhere else. It is a bit of a catch-22.”<sup>83</sup>

107. During our web-chats with higher education students, some of those studying in Wales expressed concern that a lack of STEM job opportunities in their local area tended to put off people studying STEM as it would entail their having to move and even leave Wales to pursue a career.

108. In its written evidence, Chwarae Teg referred to the limited data available on the supply and demand for individuals with STEM skills for the UK workforce and ambiguity over the skills desired by the industry. This was thought to lead to a lack of clarity over what STEM education should be trying to achieve.<sup>84</sup>

109. CollegesWales has a key role in working with employers and the sector skills councils to ensure that the skills possessed by learners match the needs of business organisations. It told us that its interventions were now directed at an early age and that it had recently had:

“800 primary school pupils coming in to spend the day with us in a vocational environment. We have to do that. The next stage is to work with employers to take them onto construction sites. I honestly believe that you cannot start too early, and that advice is best seen practically and visually as opposed to in a room with an adviser.”<sup>85</sup>

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<sup>83</sup> Record of Proceedings paragraph 319, 4 June 2014

<sup>84</sup> Chwarae Teg written evidence paragraph 4.2

<sup>85</sup> Record of Proceedings paragraph 224, 4 June 2014

110. Our predecessor Committee's report touched on the shortage of technical people for the creative industries in Wales. Dr Tom Crick reiterated the point and the "profound" importance of the "T" in STEM (Technology) for the digital and creative industries in Wales and in particular for employers such as the BBC, S4C and ITV:

"Essentially, it is not STEM; it is kind of STEMA, which is science, technology, engineering, mathematics and art. It is a fusion - you are not a luvvy or a boffin; the fusion of these skills is really important."<sup>86</sup>

**Recommendation 10: the Welsh Government should**

**Publish a formal skills audit of supply and demand for STEM skills in Wales and compare that with the projected future needs of a growing and sustainable Welsh economy.**

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<sup>86</sup> Record of Proceedings paragraph 326, 4 June 2014

## Gender and STEM

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111. Research shows that women are under-represented in STEM, and particularly in STEM apprenticeships and STEM careers, although the picture varies considerably between subject areas.

112. At GCSE level in Wales in 2013, women made up 48 per cent of entrants<sup>87</sup> for STEM subjects (and 51 per cent of all subjects). This percentage fell to 41 per cent entered for STEM subject A levels (and 55 per cent for all subjects).

113. Only 40 per cent of ICT entrants at GCSE level, and a mere 5 per cent of engineering GCSE entrants were female. We heard that all the female higher education students who took part in our web-chats were either not given or were not made aware of the option of studying engineering at GCSE level.

114. At A level the lowest female entrant rates were for physics (18 per cent) and computing (12 per cent).

115. Dr Tom Crick talked about the “disastrous and significant capability issue” regarding computing science. He told us that in 2012 the ratio of females taking A-level computing to A-level mathematics was 1:100 compared with 1:15 for males. He also referred to the “terrible” statistics for females within the IT profession, which stands at only 15 to 20 per cent.<sup>88</sup>

116. In higher education, women make up 82 per cent of veterinary science first-year enrolments and 81 per cent of subjects allied to medicine: yet only 22 per cent of computer science enrolments are female and less than 13 per cent in engineering and technology.

117. Indicative data obtained from the Annual Population Survey for Wales in 2013 showed that only 11.6 per cent of people employed in STEM occupations were female, with the highest proportions employed in health related occupations.

118. Higher Education Wales thought that gender problems in STEM were more acute in some areas than in others:

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<sup>87</sup> Joint Council for Qualifications, Provisional GCSE (Full Course) Results, June 2013

<sup>88</sup> Record of Proceedings paragraphs 288 and 312, 4 June 2014

“In terms of where you have got to focus, I think that it is rather good that we have focused on physics, because that probably is the big problem in terms of gender and science. In the biological sciences, at least at the undergraduate or school levels, you get more women coming through. Medicine is dominated by women now. On engineering, I am much more confident about engineering in the future.”<sup>89</sup>

119. Chwarae Teg has done much to increase understanding of STEM and gender issues. Its Women in Science, Technology, Engineering and Maths (STEM) Report in 2012 identified a number of issues that needed to be addressed, and included recommendations such as STEM employers providing flexible working; supplementing statutory careers service interventions by working with parents because their advice has such a significant influence on career choice; increasing the knowledge of careers professionals; and investing more resource in raising the profile of STEM in school by people working within the industry.

120. Chwarae Teg’s written evidence stated that research had shown that the largest contributing factor towards the participation of girls in STEM subjects was lack of self-confidence.<sup>90</sup> In oral evidence, Chwarae Teg made another telling point that “equalities issues generally do not necessarily resonate with a lot of people”.<sup>91</sup> It was suggested that the economic argument might therefore be more persuasive:

“50% of the potential workforce is, as we know, doing well in education, so would we not want to reach that talent pool in the same way as we reach the other 50% of the talent pool?”

121. On the other hand, Wendy Sadler told us that research by the Institute of Physics had:

“Looked at gender stereotyping within schools and the cultural problem, for the subjects that boys do not take and the subjects that girls do not take, to try to see. It found that it is almost always the culture of the school that affects whether a girl goes on. There are things that you can do to change that.”<sup>92</sup>

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<sup>89</sup> Record of Proceedings paragraph 88, 4 June 2014

<sup>90</sup> Chwarae Teg written evidence paragraph 7.3

<sup>91</sup> Record of Proceedings paragraph 131, 14 May 2014

<sup>92</sup> Record of Proceedings paragraph 67, 4 June 2014

122. During our web-chat with female STEM students we were told that physics was “really boring” and that it was “more interesting to the boys because they were more interested in engineering careers”.<sup>93</sup> We also heard that being in a male-dominated physics class could be “a little scary”.<sup>94</sup>

123. It was suggested that encouraging girls into STEM careers “has got to start early – the earlier the better before young girls have had a chance of believing that a career is only for boys”.<sup>95</sup> We were also told that women should be encouraged to study STEM “by asking female speakers in, by sending them on an experience day to colleges to work with the machines etc. to give them as much information when in school”.<sup>96</sup>

124. CollegesWales commented that there was some anecdotal evidence that more women were taking up the study of STEM subjects in colleges, but raised concerns about the lack of data for the further education sector:

“Accurate data on gender imbalances in the take up of STEM subjects in colleges or work-based learning is not easily available [sic].”<sup>97</sup>

125. We were also concerned to hear about the ratios of female to male lecturers. Anecdotal evidence from our web-chats with higher education students indicated that women were significantly under-represented in those posts.

126. Wendy Sadler told us that there was also a particular problem with losing women in STEM subjects after the postgraduate period.<sup>98</sup>

127. We therefore welcome the comment by the Chief Scientific Adviser for Wales that:

“We are looking at slightly higher up the career structure [at] bringing women back into science. I am very keen to do that. I

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<sup>93</sup> Jenna Keenan, Dentistry student, Cardiff University, web-chat 2, 30 April 2014

<sup>94</sup> Anna Lois Christian, Medicine student, Swansea Medical School, web-chat 2, 30 April 2014

<sup>95</sup> Zoe Morgan, Medicine student, Cardiff University, web-chat 2, 30 April 2014

<sup>96</sup> Robyn Moloney, BTEC Mechanical Engineering student, Coleg Sir Gâr, web-chat 2, 30 April 2014

<sup>97</sup> CollegesWales written evidence paragraph 11

<sup>98</sup> Record of Proceedings paragraph 59, 4 June 2014

am talking to the Daphne Jackson Trust, which has over a 90% success rate in bringing people back in after career breaks—mainly women—and to sponsor some fellows in Wales to bring more women back and stop losing our talent mid-career.”<sup>99</sup>

128. During our inquiry we heard of many examples of good practice that seek to redress negative perceptions and stereotypes of STEM subjects, including Techniquet’s *Getting Girls into Physics* project<sup>100</sup>, STEM Cymru’s *Girls into Engineering* project<sup>101</sup> and the construction industry’s *Be Fair* campaign.<sup>102</sup>

129. However, evidence submitted by the Institute of Physics noted that:

“Many of the activities funded through the National Science Academies have been one-off interventions and, while these activities are undoubtedly valuable in raising the profile of science in schools, it would be naïve to think that they will make any difference to the gendered uptake in the physical sciences.”<sup>103</sup>

130. Wendy Sadler informed us about the outstanding results of the Institute of Physics Stimulating Physics Network. The project trains teachers how to be aware of gender stereotypes and it costs around £4,000 per secondary school. In the schools that it has worked with in England since 2009, around 200 per cent more girls have gone on to do A-level physics than the average across the UK.<sup>104</sup>

131. Chwarae Teg highlighted the need for “gender lensing”, which checks that resources do not favour or exclude any gender and are equally engaging to everyone. It also recommended that gender awareness should be embedded in PGCE, Master of Education and Careers Service professional training to increase understanding of gender stereotyping and how to encourage more women into STEM.<sup>105</sup>

132. We heard of some not so good examples too, however. Dr Tom Crick spoke about the “pinkification of toys and the gender-targeting

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<sup>99</sup> Record of Proceedings paragraph 78, 12 June 2014

<sup>100</sup> Techniquet written evidence page 4

<sup>101</sup> Chwarae Teg written evidence paragraph 2.1

<sup>102</sup> Record of Proceedings paragraph 245, 14 May 2014

<sup>103</sup> Institute of Physics page 6

<sup>104</sup> Record of Proceedings paragraph 62, 4 June 2014 and supplementary note

<sup>105</sup> Chwarae Teg written evidence paragraph 5.2

of certain toys. LEGO is a particularly good - or, rather, bad - example of that".<sup>106</sup>

133. We also heard about the positive impact of female role models on school-aged children:

"From a STEM ambassador's point of view, we definitely need to start engaging children from a younger age. There is evidence that it needs to be done from the Foundation Phase onwards, especially by incorporating female role models from STEM industries, so that children become more aware of the variety of STEM employment and careers as well as the different career paths where they can use STEM skills that are outside the typical ones associated with STEM, such as being an engineer or doctor."<sup>107</sup>

134. Chwarae Teg told us that it was important for female role models to represent all types of STEM careers, not just high achievers:

"There is evidence that role models who are at different points in their careers and who have not reached the top of their careers are more inspirational for young people, because they can see themselves at that point, whereas seeing themselves as chief medical officer or seeing themselves right at the top is too far removed. So, broadening out our idea of what an ambassador and a role model are is helpful."<sup>108</sup>

135. The whole STEM and gender issue will not be solved overnight. Breaking down unconscious bias in society will take time. As we were told, "there is not one intervention here. We have to work at this from a number of different angles".<sup>109</sup>

136. The Chief Scientific Adviser for Wales told us that "we are looking at solutions rather than identifying the issues any further".<sup>110</sup> We welcome that approach. We also agree with Dr Crick's observation that that "if men are part of the problem, they have to be part of the solution".<sup>111</sup>

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<sup>106</sup> Record of Proceedings paragraph 312, 4 June 2014

<sup>107</sup> Record of Proceedings paragraph 147, 14 May 2014

<sup>108</sup> Record of Proceedings paragraph 163, 14 May 2014

<sup>109</sup> Record of Proceedings paragraph 159, 14 May 2014

<sup>110</sup> Record of Proceedings paragraph 77, 12 June 2014

<sup>111</sup> Record of Proceedings paragraph 315, 4 June 2014



137. We were encouraged to read from the Welsh Government’s written evidence that it is:

“Keen to understand better the issues around PISA [...] and how we can help change the perception of the sciences and technology as a career of course of study of choice. We are particularly looking to support schools further during Key Stage 4 and tackle gender differentials.”<sup>112</sup>

138. And that

“The issue of gender differentials and progression in STEM related subjects remains a priority area for the Welsh Government in taking forward grant funding, curriculum development and wider work in STEM.”<sup>113</sup>

**Recommendations 11 and 12: the Welsh Government should**

**Based on proven good practice, target more interventions at an early age to encourage girls to achieve their full potential in STEM but sustain those interventions over the long term until there is a gender balance in those subjects.**

**Work with STEM employers to develop support structures for providing more flexible and family friendly working environments and support the work of the Chief Scientific Adviser in this area.**

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<sup>112</sup> Welsh Government written evidence page 2

<sup>113</sup> Welsh Government written evidence page 6

## Language and STEM

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139. Evidence from the Wales Institute of Mathematical and Computational Sciences stated that support from Coleg Cymraeg Cenedlaethol in establishing Welsh-medium teaching posts at Aberystwyth, Swansea and Cardiff has been “an unqualified success”<sup>114</sup> in recruiting high quality students from Wales who might otherwise have gone elsewhere.

140. However, in its written evidence the Coleg Cymraeg Cenedlaethol stated that although it has tried to be involved in strategic planning and contributing to Science for Wales, it has had no direct involvement in any national strategy for the STEM agenda. The Coleg has been developing its own academic plans for sciences in partnership with Welsh higher education institutions. It stated:

“There is a need for a joined up approach in developing a STEM policy, and the Welsh language should be mainstreamed in any future strategy to promote the sciences. Without this the Welsh language will be marginal to central discussions and will continue to be treated in a tokenistic manner. It should be ensured that a certain proportion of STEM funding is earmarked specifically for use to promote skills training through the medium of Welsh.”<sup>115</sup>

141. The Construction Industry Training Board stated that there has been “limited progress” in the provision of learning through the medium of Welsh and cited a number of factors, including demand from learners, availability of bilingual lecturers, additional work costs and lack of bilingual external verifiers and examiners.<sup>116</sup>

142. The Wales Institute of Mathematical and Computational Sciences raised concerns about the lack of teaching materials in Welsh:

“There are not even any teaching materials in the medium of Welsh for, let us say, final year calculus at school matching first year, or first term, calculus at university.”<sup>117</sup>

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<sup>114</sup> WIMCS written evidence page 5

<sup>115</sup> Coleg Cymraeg Cenedlaethol written evidence paragraph 12

<sup>116</sup> CITB written evidence page 3

<sup>117</sup> Record of Proceedings paragraph 108, 14 May 2014

143. CollegesWales stated that the availability of teachers and lecturers who have both STEM and professional Welsh language skills—as with other sectors—remained a key issue.<sup>118</sup>

144. When we asked the Minister for his views on this issue, he told us that “we are not where we need to be” and he saw the need for “more fluent Welsh speakers as teachers in STEM subjects, and in physics in particular”.<sup>119</sup>

**Recommendations 13 and 14: the Welsh Government should**

**Ensure a joined-up approach so that the Welsh language is mainstreamed in strategies and policies to promote STEM.**

**Address the lack of availability of STEM teaching materials in the medium of Welsh.**

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<sup>118</sup> CollegesWales written evidence paragraph 11

<sup>119</sup> Record of Proceedings paragraph 100, 12 June 2014

## Annex A - Inquiry terms of reference

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The terms of reference for the inquiry were to explore:

- What impact has the Welsh Government's strategy *Science for Wales* and Delivery Plan had on STEM skills in Wales?
- What progress has been made in addressing the issues identified in the Third Assembly's Enterprise and Learning Committee inquiry in 2011 into the STEM agenda, including:
  - the adequacy of provision of STEM skills in schools, further education colleges, higher education and work-based learning (including apprenticeships);
  - value for money from the additional funding to support and promote STEM skills and whether the current supply of STEM skills is meeting the needs of the Welsh labour market;
  - the supply of education professionals able to teach STEM subjects and the impact of Initial Teacher Training Grants and the Graduate Teacher Programme on recruiting STEM teachers and education professionals;
  - the effectiveness of education and business links between education institutions and STEM employers.
- Whether any progress has been made on addressing negative perceptions and gender stereotypes of STEM and promoting good practice to encourage women to acquire STEM skills and to follow STEM related careers.
- What progress has been made on learning STEM skills through Welsh medium education and training?

## Witnesses

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The following witnesses provided oral evidence to the Committee on the dates noted below. Transcripts of all oral evidence sessions can be viewed at [the Assembly website](#).<sup>120</sup>

### **30 April 2014 – web-chat with higher education students**

#### **Web-chat 1**

Catherine Louise Jones, Biomedical Science student, Aston University

Aled Illtud, Physics student, Aberystwyth University

Chris Lorch, Planetary and Space Physics student, Aberystwyth University

Ryan Myles-Roberts, Masters Mathematics student, Aberystwyth University

Benjamin Williams, BTEC Electronic Engineering student, Coleg Sir Gâr

#### **Web-chat 2**

Anna Lois Christian, Medicine student, Swansea Medical School

Elen Pierce Everett, Masters Biomedical Research student, Cardiff University

Rebecca Hanley, Masters Mathematics student, Exeter University

Jenna Keenan, Dentistry student, Cardiff University

Robyn Moloney, BTEC Mechanical Engineering student, Coleg Sir Gâr

Zoe Morgan, Medicine student, Cardiff University

### **14 May 2014**

National Science Academy:

Dr Anita Shaw, Deputy Chief Executive, Techniquest

Professor Niels Jacob, Head of the Mathematics Department, Swansea University, Wales Institute of Mathematical and Computational Sciences

Jane Richmond, Head of Learning and Interpretation, The National Botanic Garden of Wales

Joy Kent, Chief Executive, Chwarae Teg

Emma Richards, Business Development Officer, Chwarae Teg

Alice Gray, STEM Ambassador

Donna Griffiths, Skills Strategy Manager Wales, Construction Industry Training Board

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<sup>120</sup> [www.senedd.assemblywales.org/mglIssueHistoryHome.aspx?lId=1307](http://www.senedd.assemblywales.org/mglIssueHistoryHome.aspx?lId=1307)

#### **4 June 2014**

Professor Richard B Davies, Higher Education Wales (Vice-Chancellor, Swansea University)

Wendy Sadler, Schools Liaison Officer, School of Physics and Astronomy, Cardiff University

Professor Andy Evans, Institute Director, Department of Mathematics and Physics, Aberystwyth University

Richard Spear, Chief Executive, Careers Wales

Dr Greg Walker, Deputy Chief Executive, CollegesWales

Barry Liles, Principal, Coleg Sir Gâr

Dr Tom Crick, Senior Lecturer in Computing Science, Cardiff Metropolitan University

#### **12 June 2014**

Huw Lewis AM, Minister for Education and Skills

Ken Skates AM, Deputy Minister for Skills and Technology

Professor Julie Williams, Chief Scientific Adviser for Wales

Pat McCarthy, Senior Policy Developer and Implementation Manager

## List of written evidence

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The following people and organisations provided written evidence to the Committee. All written evidence can be viewed in full on the [Committee website](#).<sup>121</sup>

### Organisation

Cardiff Science Institute Initiative

Cardiff University

Chwarae Teg

Chwarae Teg – note on research on women returners forced out of work

Coleg Cymraeg Cenedlaethol

CollegesWales

Construction Industry Training Board Cymru Wales

Field Studies Council

Higher Education Funding Council for Wales

Institute of Mathematics, Physics and Computer Science, Aberystwyth University

Institute of Physics

Professor Mike Phillips, University of Wales, Trinity St David

Royal Society of Chemistry

Wendy Sadler – supplementary note on the Stimulating Physics Network

STEM Business Group – Northern Ireland

Techniquest

Wales Institute of Mathematical and Computational Sciences

Welsh Government

Welsh Government – note on the Further Maths Support Programme Wales

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<sup>121</sup> [www.senedd.assemblywales.org/mgConsultationDisplay.aspx?ID=113](http://www.senedd.assemblywales.org/mgConsultationDisplay.aspx?ID=113)