

National Assembly for Wales
Enterprise and Learning Committee

The science, technology, engineering
and mathematics (STEM) agenda

January 2011



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Enterprise and Learning Committee

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Enterprise and Learning Committee

The Enterprise and Learning Committee was established by the National Assembly for Wales to consider and report on issues within the areas of economic development, transport, education and skills. In particular, the Committee may examine the expenditure, administration and policy of the Welsh Government and associated public bodies.

Powers

The Committee was established following the National Assembly Elections in May 2007 as one of the Assembly's scrutiny committees. Its powers are set out in the National Assembly for Wales's Standing Orders, particularly Standing Order 12. These are available at: <http://www.assemblywales.org/bus-home/bus-guide-docs-pub/bus-assembly-guidance.htm>

Committee membership

Committee Member	Party	Constituency / Region
Gareth Jones (Chair)	Plaid Cymru	Aberconwy
Christine Chapman	Labour	Cynon Valley
Jeff Cuthbert	Labour	Caerphilly
Andrew Davies	Labour	Swansea West
Paul Davies	Welsh Conservative Party	Preseli Pembrokeshire
Nerys Evans	Plaid Cymru	Mid and West Wales
Brian Gibbons	Labour	Aberavon
David Melding (until 1 December 2010)	Welsh Conservative Party	South Wales Central
Darren Millar (from 1 December 2010)	Welsh Conservative Party	Clwyd West
Jenny Randerson	Welsh Liberal Democrats	Cardiff Central

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The Committee's Recommendations

The Committee's recommendations to Welsh Ministers 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.

Recommendation 1. We recommend that the Welsh Assembly Government should carry out a study of why science in primary schools may be experiencing a decline, and should explore with Estyn how best to assess science performance in the future. (Page 14)

Recommendation 2. We recommend that the Welsh Assembly Government should research the relationship between pupils' study of either combined science or separate science at GCSE and their final A-level grades. (Page 16)

Recommendation 3. We further recommend that the Welsh Assembly Government should encourage more schools to offer triple science, but in those schools that do not, the Government should work with partners to ensure that pupils have access to studying triple science in nearby schools or colleges. (Page 16)

Recommendation 4. We recommend that the Welsh Assembly Government should continue to explore the best means of monitoring the quality, independence and timeliness of advice offered to young people to inform their choice of subjects and STEM-related career paths. (Page 18)

Recommendation 5. We recommend that the Welsh Government should continue to ensure that implementation of its transformation agenda puts the needs of the learner at the centre so that young people have access to the range and quality of opportunities that will take them along their chosen career or learning pathway. (Page 19)

Recommendation 6. We recommend that the Chief Scientific Adviser, through the National Science Academy, should evaluate initiatives aimed at addressing negative perceptions and gender stereotypes of STEM subjects and should promote good practice within the school system, starting at the earliest possible age. (Page 20)

Recommendation 7. We recommend that all the Sector Skills Councils should be charged with identifying gender imbalances in their respective sectors and where there are problems, should develop an action plan for addressing those issues. (Page 21)

Recommendation 8. We recommend that the Welsh Assembly Government should, through implementation of the Welsh medium education strategy, place higher expectations on local education authorities to offer teachers with Welsh language skills the opportunity to increase their confidence to teach in a Welsh-medium school. (Page 21)

Recommendation 9. We look forward to Estyn's report on engineering in post-16 education, which is expected in spring 2011, and recommend that Welsh Ministers should act on its findings, including developing measures to improve the link between industry and education institutions. (Page 24)

Recommendation 10. We recommend that the Welsh Assembly Government should publish a continuous professional development plan for teachers in Wales, including those in Welsh medium education, aimed at improving in-service training and updating for STEM teachers and heads of department, not only to enhance their subject knowledge but also their understanding of how to teach specific subject topics up to GCSE level at the very least. (Page 28)

Recommendation 11. For the longer term we recommend that the Welsh Assembly Government should produce definitive data on the quantity and quality of STEM teachers and develop measures for encouraging and recruiting high quality physics, chemistry and mathematics teachers where there is an identified need. (Page 28)

Recommendation 12. We recommend that the Welsh Assembly Government should contract the Education Business Partnerships (Careers Wales) to develop strategic partnerships between schools and industry in order to increase opportunities for teacher and lecturer placements or sabbaticals with STEM employers as part of teachers' continuous professional development. (Page 29)

Recommendation 13. We recommend that the Welsh Assembly Government should commission research on why STEM graduates do not progress into STEM jobs, and on whether this is an issue for concern or not. (Page 31)

Recommendation 14. We recommend that existing good practice by some of the Sector Skills Councils should be extended so that there are more strategic partnerships between employers and educational institutions to align curricula and qualifications more closely and to better equip students with the knowledge and the skills required for STEM employment. (Page 32)

Recommendation 15. We further recommend that the Welsh Assembly Government should proceed in its proposals to commission a formal skills audit of the supply of and future demand for STEM skills in Wales so that the two sides can be better matched accordingly. (Page 32)

Recommendation 16. We recommend that the Welsh Assembly Government should work with the Sector Skills Councils and Careers Wales to develop a framework for a continuum of learning from the Foundation Phase onwards in which schools and employers can be linked together more effectively in providing stimulating programmes to complement the STEM curriculum, including high quality, meaningful work placements that can give young people a taste of the skills they will need to be productive and successful in the world of work. (Page 34)

Recommendation 17. We recommend that higher education degree courses should put greater emphasis on practical application and independent experimental work, and that assessment frameworks need to reflect this emphasis. (Page 35)

Recommendation 18. We recommend that the Welsh Assembly Government should ensure that Wales capitalises on non-domestic funding opportunities so that higher education institutions can work with local authorities and with high-tech industries in their areas on joint bids to develop innovative projects aimed at encouraging the take-up of STEM in education and employment. (Page 37)

Recommendation 19. We recommend that higher education institutions and individual academics in Wales should be challenged to lever their academic STEM success into economic and educational areas through collaborative working with businesses and schools, and that the Chief Scientific Adviser for Wales should play the key role in joining up and providing quality control of different initiatives in this area. (Page 37)

Recommendation 20. We recommend that in taking forward its work the Science Advisory Council for Wales should also promote the other three STEM disciplines as well as closely engage with Welsh employers and industrialists in those sectors. (Page 39)

Recommendation 21. We recommend that the Welsh Assembly Government should, through the Chief Scientific Adviser, develop and monitor performance against an action plan to promote the whole STEM agenda in Wales, through setting clear long-term objectives, and shorter-term priorities and targets. (Page 41)

Recommendation 22. We also recommend that in formulating his future work programme, the Chief Scientific Adviser should be charged with taking forward the recommendations of our report. (Page 41)

Introduction

“A strong research base and a pool of workers with good science, technology, engineering and mathematics (STEM) skills are essential for an innovative, modern economy.”¹

1. This was the opening comment of Lesley Griffiths AM, Deputy Minister for Science, Innovation and Skills, in giving evidence to our inquiry.
2. The reality is less upbeat, however. During the course of our inquiry the Programme for International Student Assessment (PISA)² 2009 results were published, which depicts a very disappointing picture of Wales’s educational performance. In mathematics Wales scored significantly lower than the OECD average and the other UK countries. Wales’s performance in science was slightly better but still below that of our UK counterparts. In both subject areas, Wales’s mean score and ranking was lower than in 2006.
3. In the context of these trends, and the fact that work has started on preparing the Welsh Government’s new science policy for Wales,³ this seemed to us an opportune time to assess the current state of STEM skills in the Welsh education system and in the workplace. Our inquiry was also timely in that the new Chief Scientific Adviser for Wales was on the verge of mapping out his future vision and strategy for the new National Science Academy to improve the supply of scientists, technologists, engineers and mathematicians in Wales.
4. It is fair to say that our inquiry into the STEM agenda provoked some strong views, and perceptions of the issue were not necessarily reflected in the available evidence. For example, while employers may claim they face problems attracting staff at NVQ Level 3/4, especially in engineering, latest figures from the Higher Education Careers Services Unit reported that unemployment for IT graduates was 16 per cent and for engineering graduates above 10 per cent.⁴ Similarly, the claim that teaching in science is worse than in other subjects does not

¹ Record of Proceedings paragraph 7, Enterprise and Learning Committee, 8 December 2010

² PISA is an internationally standardised assessment that was jointly developed by participating countries and is administered by the Organisation for Economic Cooperation and Development (OECD) to 15 year-olds in schools every three years

³ Welsh Government written evidence page 10

⁴ Welsh Government written evidence page 5

necessarily translate into pupil performance: Wales's international performance in the science domain is better than in reading, for example.⁵ We discovered other anomalies during our inquiry, which we explore later in this report.

5. We are very grateful to the many organisations and individuals who contributed to our inquiry; the oral and written evidence we received is listed at the end of this report.

⁵ Record of Proceedings paragraph 138, Enterprise and Learning Committee, 8 December 2010

Policy Background

6. Since the first science policy for Wales was published⁶ there have been a number of other policies and initiatives relating to STEM skills. The Welsh Government's skills strategy and action plan,⁷ for example, states that:

“Science, technology, engineering and maths (STEM) graduates offer skills and knowledge that are highly valued in the labour market. Chemistry and physics graduates will earn, on average, 30% more over their working lives than A-level holders, a significantly higher premium than graduates in subjects including psychology, linguistics, and history. Employers tell us that the demand for STEM graduates is likely to grow significantly over the next few years.”

7. The Welsh Government's higher education strategy and plan⁸ also identifies the importance for the Welsh economy of developing stronger high-level skills and leading-edge research in science, technology, engineering and mathematics. In the same month that the strategy and action plan was published, the UK Government announced its National Higher Education STEM programme, the second stage of a six-year programme that began in 2006. The first stage involved pilot projects developed by partners to generate interest in chemistry, physics, mathematics and engineering among young people and to enhance the accessibility of higher education courses in these subjects. The second stage, funded by £21 million from the Higher Education Funding Councils for England and Wales, supports higher education institutions in exploring new approaches to recruiting students and delivering programmes of study within the STEM disciplines. The higher education STEM Programme in Wales is managed by the Wales Institute of Mathematical and Computational Sciences based at Swansea University.

8. The three most recent developments in the STEM field are the appointment in February 2010 of Professor John Harries as the first

⁶ A Science Policy for Wales – The Welsh Assembly Government's Strategic Vision for Sciences, Engineering and Technology, was published in November 2006

⁷ Skills that Work for Wales Strategy and Action Plan, Welsh Assembly Government, July 2008

⁸ For Our Future – The 21st Century Higher Education Strategy and Plan for Wales, Welsh Assembly Government, November 2009

Chief Scientific Adviser for Wales, to coordinate current and future initiatives for promoting the take-up of STEM and to overcome any barriers that discourage learners. In April 2010 the Welsh Government announced the establishment of the National Science Academy (directed by the Chief Scientific Adviser) to promote the take-up of STEM at all levels to ensure Wales has a continuous stream of graduates with the appropriate qualifications and skills. In October 2010 the Government announced the STEM Cymru project, led by the Engineering Education Scheme in Wales and aimed at encouraging 12 to 19-year olds to study STEM subjects and participate in industry-linked technological and engineering activities.

Acquisition of STEM skills

STEM in schools

9. Mathematics and science are core school subjects that have to be studied to GCSE level. Science can be taught in three separate subjects (biology, chemistry and physics) or combined into science and additional science. In the latter case, pupils are awarded two GCSE grades for a combination of the marks from the individual subjects, which are studied in less depth than when studied individually.⁹

10. WJEC¹⁰ told us that successful development of STEM skills in the curriculum was dependent on having stimulating and relevant learning programmes, learners with positive attitudes and aptitudes, and professional and inspirational teachers and lecturers.¹¹

11. Estyn's¹² inspections of secondary schools have revealed "significantly lower" standards in science and mathematics than in other subjects.¹³ Estyn's evidence also referred to research by the Royal Society which showed that the proportion of learners in Wales taking biology, chemistry, physics and mathematics at A-level was significantly below that of the rest of the UK.¹⁴

12. Estyn's inspections have shown that the picture is more mixed in primary schools, although there has been a recent decline in standards in science and mathematics relative to other subjects.¹⁵ When we later questioned Estyn about the reasons for this decline, it was suggested that it could be because science is tending to be taught thematically or because there is a lack of scientific capacity in local authorities and advisory services in supporting the strength of science.¹⁶

13. Based on Royal Society findings, the WJEC sounded a warning about a return to broad "topics" at primary level because of the shortage of science specialists in the primary school workforce, which could be out of line with global trends for raising the status of science

⁹ Institute of Physics in Wales written evidence page 2

¹⁰ Welsh Joint Education Committee

¹¹ WJEC written evidence section 2

¹² Her Majesty's Inspectorate for Education and Training in Wales

¹³ Estyn written evidence paragraph 3

¹⁴ Estyn written evidence paragraph 13

¹⁵ Estyn written evidence paragraph 4

¹⁶ Record of Proceedings paragraph 67, Enterprise and Learning Committee, 10 November 2010; Association for Science Education Cymru written evidence page 2

in pre-secondary education.¹⁷ We also heard anecdotally that science is no longer a core part of the assessment framework in primary schools.¹⁸

14. Whatever the causes, this trend deeply concerns us. Positive experience and engagement with STEM at primary level is key to pupils being enthused to continue with those subjects in their later education¹⁹ and careers.²⁰ In our view, projects in the Foundation Phase are an ideal vehicle for stimulating an early appetite for STEM and the pursuit of scientific knowledge.

We recommend that the Welsh Assembly Government should carry out a study of why science in primary schools may be experiencing a decline, and should explore with Estyn how best to assess science performance in the future.

15. On a more positive note, Stuart Jones, Deputy Head at St Alban's Roman Catholic School in Pontypool, told us that more 11 to 19 year-olds are now engaged in the sciences, and the sciences are being taught more engagingly than ever before. However, he identified there was still a lack of young people taking up STEM subjects as a career, and science was still taught in "boxes".²¹ We address this issue in more detail in paragraph 84 below.

Separate versus combined sciences

16. WJEC told us that there has been a recent increase in the number of GCSE pupils studying three separate science subjects,²² although its written evidence stated that a "considerable proportion" (possibly over 40 per cent) of schools in Wales do not offer the separate sciences at GCSE.²³ From our understanding of the Learning and Skills (Wales) Measure 2009, there is no statutory requirement regarding access to studying triple science in other nearby schools or colleges.

¹⁷ WJEC written evidence section 3.2

¹⁸ Record of Proceedings paragraphs 124-127, Enterprise and Learning Committee, 8 December 2010

¹⁹ Association for Science Education Cymru written evidence page 2

²⁰ Royal Society of Chemistry written evidence page 1

²¹ Record of Proceedings paragraphs 98-101, Enterprise and Learning Committee, 10 November 2010

²² Record of Proceedings paragraph 16, Enterprise and Learning Committee, 10 November 2010

²³ WJEC written evidence section 3.1

17. The increase in take-up of A-level mathematics has increased from 2008 onwards, although there has been a downward trend in “other science” courses such as zoology, probably because of the difficulties in sustaining such courses for small numbers of learners. Estyn told us that it was “disappointed” with the operation of the 14-19 options menu because it had not been sufficiently flexible.²⁴

18. Opinions on whether sciences at GCSE should be taught separately or combined (double science) were fairly robust. First, we heard that because triple science required more teaching time, practical and investigative work tended to be squeezed or timetabled into lunch breaks.²⁵

19. Secondly, we heard that combined science does not ground pupils in the basic concepts and skills and does not prepare them for taking science subjects at A-level. Q Chip Ltd referred to combining all three sciences as “a disaster.”²⁶

20. We were told that double award GCSE science was considered by further education teachers not to provide sufficient physical science background to prepare learners for engineering sciences post-16. Cardiff University stated that as one of the major recruiters of STEM undergraduates in Wales, it found the STEM skills of current school leavers was “not adequately strong” and that it spent “a large proportion of the first year bringing the students ‘up to speed’.”²⁷

21. Q Chip Ltd further argued that:

“If science graduates with minimum practical training then become secondary school teachers the cycle will be perpetuated, students should begin rigorous practical training at GCSE and most certainly A-level.”²⁸

22. In WJEC’s opinion, the determining factor in the separate versus combined science debate was the leadership and quality of teaching,

²⁴ Record of Proceedings paragraph 27, Enterprise and Learning Committee, 10 November 2010

²⁵ Record of Proceedings paragraphs 41-45, Enterprise and Learning Committee, 10 November 2010; Undeb Cenedlaethol Athrawon Cymru written evidence page 1

²⁶ Q Chip Ltd written evidence page 3. Q Chip is a biopharmaceutical company based in Cardiff

²⁷ Cardiff University written evidence page 2

²⁸ Q Chip Ltd written evidence page 2

regardless of the options pupils take,²⁹ a view shared by Tinopolis Ltd.³⁰

23. In November 2010 the National Audit Office published the report “Educating the next generation of scientists”³¹ which revealed that pupils in England who study triple science (three separate sciences) are more likely to choose and succeed in science at A-level and degree level than those studying combined (double) science. A-level pupils who had previously studied double science at GCSE achieved, on average, one grade lower at A-level than those who had studied a separate GCSE in that science. The report also quoted recent research which has shown that pupils from more deprived backgrounds achieved relatively larger improvements in their A-level science and mathematics outcomes when offered triple science at GCSE than when offered only combined science. Yet triple science is less widely available in areas of higher deprivation.

We recommend that the Welsh Assembly Government should research the relationship between pupils’ study of either combined science or separate science at GCSE and their final A-level grades.

We further recommend that the Welsh Assembly Government should encourage more schools to offer triple science, but in those schools that do not, the Government should work with partners to ensure that pupils have access to studying triple science in nearby schools or colleges.

24. Yet still further than that, we believe there is merit in considering a more fundamental review of the curriculum to ensure that STEM subjects are properly designed, resourced, taught and timetabled, with plenty of opportunity for practical work that motivates and encourages students to study STEM subjects at a higher level. As one Welsh

²⁹ Record of Proceedings paragraph 47, Enterprise and Learning Committee, 10 November 2010; Estyn supplementary evidence paragraph 1

³⁰ Record of Proceedings paragraph 69, Enterprise and Learning Committee, 17 November 2010. Tinopolis is an independent media producer with headquarters in Llanelli

³¹ The NAO report evaluated progress made in England by the Department for Education in increasing the take-up and achievement in mathematics and science by pupils up to age 18

Government official said, there is a need to “bring the curriculum to life.”³²

25. WJEC thought that it was a case of ensuring the “right balance between theory, practice, practical work, application and industrial experience and make all of it relevant,” as well as a balance in the design of learning programmes, the day-to-day learning experience and in the assessment.³³ We were therefore interested to hear about WJEC’s initiative of building into qualifications explicit opportunities to make connections with industry;³⁴ we see this as the way forward.

26. We appreciate that the current curriculum is crowded, and also that it takes time to align curricula with employment opportunities, but intelligence about the labour market must be employed to good effect in ensuring there is a match between the supply and the demand for STEM-skilled young people. We return in more detail to the re-alignment of supply and demand of skills in paragraphs 68 to 77 below.

Making the right choices

27. We were concerned to hear from Estyn that it has identified “a lack of unbiased advice” for pupils at the ages of 13 and at 16.³⁵ Research by EngineeringUK also revealed that 40 per cent of advisers wrongly believed A-levels and a degree were the only route to an engineering career - whereas apprenticeships and further education are also routes.³⁶

28. The Institute of Physics in Wales suggested careers advisers should be trained about science opportunities and science teachers trained about careers.³⁷ BT Wales said that “young people are not adequately informed about their choices and we as employers must

³² Record of Proceedings paragraph 143, Enterprise and Learning Committee, 8 December 2010

³³ Record of Proceedings paragraph 37, Enterprise and Learning Committee, 10 November 2010

³⁴ Record of Proceedings paragraph 39, Enterprise and Learning Committee, 10 November 2010

³⁵ Record of Proceedings paragraph 19, Enterprise and Learning Committee, 10 November 2010

³⁶ EngineeringUK written evidence section 3

³⁷ Institute of Physics in Wales

hold our hands up and say that part of this responsibility lies with us.”³⁸

29. Welsh Government officials believed it was important to engage with pupils under the age of 14 to enable them to understand that “the pursuit of STEM subjects in particular is likely to provide them with a better chance of gaining good career-oriented employment - more so than other subjects.”³⁹

30. The Minister told us that:

“We cannot have a situation where young people’s ambitions are fettered, but nor can we have a situation where they are misled - where they are told that provision is relevant when it is not, and it is simply a device to keep them within a particular part of the system, rather than opening up opportunities for them that might be provided on a more collaborative basis.”⁴⁰

We recommend that the Welsh Assembly Government should continue to explore the best means of monitoring the quality, independence and timeliness of advice offered to young people to inform their choice of subjects and STEM-related career paths.

31. The Minister also stated that this issue went “straight to the heart of the collaboration agenda” and that:

“We must get out of the rhetoric of learner choice, which has dominated education thinking in the past decade or probably the past 20 years, and really look at the quality of what is being offered. I would much rather see a focus on quality than on choices, which, at the end of the day, are not quality.”⁴¹

³⁸ BT Wales written evidence paragraph 9e

³⁹ Record of Proceedings paragraph 23, Enterprise and Learning Committee, 8 December 2010

⁴⁰ Record of Proceedings paragraph 149, Enterprise and Learning Committee, 8 December 2010

⁴¹ Record of Proceedings paragraph 147, Enterprise and Learning Committee, 8 December 2010

32. The Education Business Partnership (Careers Wales)⁴² also told us that:

“To provide a truly local curriculum, colleges, schools and employers must be entirely collaborative. There is little room for preserving your own brand in such a set up.”⁴³

We recommend that the Welsh Government should continue to ensure that implementation of its transformation agenda puts the needs of the learner at the centre so that young people have access to the range and quality of opportunities that will take them along their chosen career or learning pathway.

Gender differences

33. The importance of giving young people unbiased advice and equality of opportunity is particularly acute when it comes to issues of gender imbalance within the STEM agenda.

34. In its written evidence, Estyn highlighted the differences in take-up of STEM subjects between boys and girls.⁴⁴ Information sourced by our Members’ Research Service found that with the exception of biology and chemistry, there is a gender imbalance in A-levels across the majority of STEM subjects (mathematics, Information Communication Technology (ICT), physics and computing).

Proportion of female A-Level students by STEM subject in 2008⁴⁵
Per cent

	Students
All subjects	54
Biology	58
Chemistry	49
Mathematics	40
ICT	38
Physics	22
Computing	9

⁴² The Welsh Government assigns the role of brokering links between education institutions and employers to the education business partnerships, which are part of the Careers Wales companies

⁴³ Record of Proceedings paragraph 157, Enterprise and Learning Committee, 10 November 2010

⁴⁴ Estyn written evidence paragraph 13

⁴⁵ British Computer Society, e-skills UK, Intellect, [*Women in IT scorecard*](#), March 2009

35. The Education Business Partnership (Careers Wales) suggested that differences in take-up could be attributed to girls' "misconceptions" about physics, often from parental pressure, and that gender stereotyping should be addressed at the earliest age possible in primary schools.⁴⁶ Stuart Jones thought the answer lay in "changing perceptions."⁴⁷

36. The proportion of females applying for higher education in STEM-related subjects is 38 per cent (compared with 55 per cent for all subjects) and the acceptance is 27 per cent (compared with 54 per cent). For engineering, the proportions drop to 13 per cent and 12 per cent respectively.⁴⁸

37. GE Aviation Services also highlighted the lack of females in engineering and stated that not enough was being done to promote careers in engineering to female students.⁴⁹

38. We appreciate that regardless of the career advice they receive, young people are still strongly guided by the perceptions of their parents, teachers and their peers, and from a very early age.⁵⁰ Yet it is essential that girls have the same opportunities as boys in studying STEM subjects and in progressing into STEM-related careers if they are to utilise their talents to the full.

We recommend that the Chief Scientific Adviser, through the National Science Academy, should evaluate initiatives aimed at addressing negative perceptions and gender stereotypes of STEM subjects and should promote good practice within the school system, starting at the earliest possible age.

39. Further than that, we believe that industry itself has a responsibility to address gender biases in particular sectors.

⁴⁶ Record of Proceedings paragraphs 149 and 161, Enterprise and Learning Committee, 10 November 2010

⁴⁷ Record of Proceedings paragraph 114, Enterprise and Learning Committee, 10 November 2010

⁴⁸ BCS, e-skills UK, Intellect, *Women in IT scorecard*, March 2009

⁴⁹ GE Aviation Services – Wales written evidence page 1. GE Aviation Services is an aero-engine maintenance, repair and overhaul facility based in Caerphilly

⁵⁰ Record of Proceedings paragraph 190, Enterprise and Learning Committee, 8 December 2010

We recommend that all the Sector Skills Councils should be charged with identifying gender imbalances in their respective sectors and where there are problems, should develop an action plan for addressing those issues.

Welsh language

40. Estyn's written evidence referred to the low proportion (less than 15 per cent) of newly qualified physics teachers able to teach through the medium of Welsh, although a quarter of secondary schools in Wales are Welsh-medium.⁵¹

41. Estyn later told us that:

“The challenge facing Welsh-medium schools is the same as that facing English-medium schools: attracting graduates of the highest quality to teach children, although the situation is worse for Welsh-medium schools.”⁵²

We recommend that the Welsh Assembly Government should, through implementation of the Welsh medium education strategy, place higher expectations on local education authorities to offer teachers with Welsh language skills the opportunity to increase their confidence to teach in a Welsh-medium school.

42. Written evidence provided by the Institute of Physics in Wales informed us that there has been a recent rise in the number of pupils studying physics A-level through the medium of Welsh.⁵³ We were concerned to receive evidence from Q Chip Ltd, however, which argued that teaching STEM subjects through the medium of Welsh could put students at a disadvantage because English is the global language in academia and industry.⁵⁴ This view was not shared by BT Wales or by Tinopolis.⁵⁵

43. When we asked the Minister for his view he told us:

⁵¹ Estyn written evidence paragraph 15

⁵² Record of Proceedings paragraph 74, Enterprise and Learning Committee, 10 November 2010

⁵³ Institute of Physics in Wales written evidence page 6

⁵⁴ Q Chip Ltd written evidence page 3; Record of Proceedings paragraphs 160-176, Enterprise and Learning Committee, 17 November 2010

⁵⁵ Record of Proceedings paragraphs 44-45, Enterprise and Learning Committee, 17 November 2010

“I see no reason why we should want to discourage people from studying through the medium of Welsh. I do not know whether we have the necessary evidence to support this claim, as I suspect that much of it is anecdotal, but there may well be innovative companies in Wales that are exploring developments in science through the medium of Welsh, and we would not want to discourage that.”⁵⁶

44. We subsequently asked whether any assessment has been carried out on the impact that learning a STEM subject through the medium of Welsh has on student performance or on career progression into STEM-related employment.

45. Careers Wales was not aware of any work that has been done on this on a Wales level.⁵⁷ Supplementary evidence provided by Estyn revealed that over the 2007 to 2010 period standards, teaching and assessment outcomes were generally better in Welsh medium schools, although whether learning and teaching are provided through the Welsh language in those schools varies: at key stage 3, most Welsh medium schools teach science through the medium of Welsh but at key stages 4 and 5 the situation is more complex because some schools offer pupils a choice of language or use a bilingual approach.⁵⁸

Engineering

46. Estyn stated that engineering was often promoted as a choice for “less able learners,” who often struggle with the mathematical content of the courses – although this problem was being addressed.⁵⁹ When we later questioned Estyn on this issue, we were told that:

“What is significant about students who are in post-16 education is that there are complaints that the reason for the lack of success by the 20 per cent who do not succeed, often, are the weaknesses in mathematics during their studies prior to them coming to college and weaknesses in the double science

⁵⁶ Record of Proceedings paragraph 112, Enterprise and Learning Committee, 8 December 2010

⁵⁷ Email to the Deputy Clerk dated 7 January 2011

⁵⁸ Estyn supplementary evidence

⁵⁹ Estyn written evidence paragraph 9

course, as it does not prepare pupils adequately for engineering courses at level 3.”⁶⁰

47. GE Aviation Services also thought that engineering apprenticeships were perceived as a career route for lower achieving students.⁶¹ The company told us that:

“Our experience, and this can be verified by Coleg Morgannwg, is that a large number of those who have the equivalent rather than the GCSE grade C have struggled with the mathematics element on the BTEC aerospace course, which is an essential and core element of their apprenticeship. We have had to put in additional efforts to get them to the required standard in order for them to be able to cope with the mathematics, which is critical for the role that they do.”⁶²

48. The Engineering Education Scheme in Wales too believed that technology and engineering were “generally treated as less important”⁶³ than the other STEM subjects.

49. While GE Aviation Services argued that engineering at school level was “very limited”,⁶⁴ Estyn told us that engineering, manufacturing and technology “appeared to be prospering” in further education. Carmarthenshire College and Deeside College were highlighted as having good links with local engineering firms,⁶⁵ although the general situation was considered patchy – a picture also portrayed by WJEC.⁶⁶

50. Written evidence from the Association of Managers in Education commented that:

“Careers Wales and local industry tell schools and colleges that more people with STEM skills are needed, engineering in particular. Many colleges across Wales are pushing out their Engineering BTECs, but when one member asked Careers Wales

⁶⁰ Record of Proceedings paragraph 14, Enterprise and Learning Committee, 10 November 2010

⁶¹ GE Aviation Services – Wales written evidence page 1

⁶² Record of Proceedings paragraph 184, Enterprise and Learning Committee, 17 November 2010

⁶³ Engineering Education Scheme in Wales written evidence page 3

⁶⁴ GE Aviation Services written evidence page 1

⁶⁵ Record of Proceedings paragraph 13, Enterprise and Learning Committee, 10 November 2010

⁶⁶ Record of Proceedings paragraph 38, Enterprise and Learning Committee, 10 November 2010

to find out at what level engineers are in demand – it turns out to be at least level 3 and mainly graduate level, so it seems as if many colleges may be providing courses at too low a level.”⁶⁷

51. Estyn identified the need to provide schools with engineering expertise from industry, and also to update the industrial experience of further education teachers.⁶⁸ Most of all, however, Estyn believed that “more effort could be made on both sides” (colleges and employers) to improve the situation.⁶⁹

We look forward to Estyn’s report on engineering in post-16 education, which is expected in spring 2011, and recommend that Welsh Ministers should act on its findings, including developing measures to improve the link between industry and education institutions.

⁶⁷ Association of Teachers and Lecturers and Association for College Management joint written evidence page 2

⁶⁸ Record of Proceedings paragraph 32, Enterprise and Learning Committee, 10 November 2010

⁶⁹ Record of Proceedings paragraph 36, Enterprise and Learning Committee, 10 November 2010

Teaching of STEM

Leadership and supply of STEM professionals

52. Estyn told us that “two things motivate pupils: good teaching and a link to what they are interested in and what can open doors for them.”⁷⁰

53. Estyn stated that the quality of teaching in secondary schools is poorer in science and mathematics than in other subjects, and those departments are less well led.⁷¹

“We note that there are significant deficiencies in the leadership of almost half the science departments in our secondary schools.

[...]

“Our interpretation therefore is that there is a vicious circle, namely that relatively poor-quality teaching in schools leads to fewer young people choosing to study STEM subjects to a higher level, fewer STEM graduates and, in turn, difficulties in recruiting good STEM teachers, particularly in the physical sciences. That is apart from the need to create the jobs that will lead our economy and industry in Wales.”⁷²

54. Estyn made a further point about teaching professionals:

“About the same number of biology teachers gain qualified teacher status in Wales as chemistry and physics teachers put together. Because the background of most science teachers is in biology, specialist physics (and to a lesser extent chemistry) teachers tend predominantly to teach GCSE and A-level classes. As a result, a disproportionate amount of teaching at key stage 3 is delivered by teachers with only a biology background. This means that their pupils may not gain a sound skill base in

⁷⁰ Record of Proceedings paragraph 54, Enterprise and Learning Committee, 10 November 2010

⁷¹ Estyn written evidence paragraphs 5-6

⁷² Record of Proceedings paragraph 11, Enterprise and Learning Committee, 10 November 2010

physics or be sufficiently motivated to take up study of the physical sciences at a higher level.”⁷³

55. Indeed, General Teaching Council for Wales data quoted by the Institute of Physics in Wales revealed that in 2010 there were 158 physics teachers in Wales who were trained in the subject, but 198 teachers teaching physics where their training was not in physics. The Institute therefore concluded that it was “crucial that we increase the number of teachers with specialist expertise and fully support those teachers who are teaching outside of their specialism.”⁷⁴

56. Written evidence from Software Alliance Wales also stated that there were insufficient numbers of trained ICT and computer science teachers in Welsh schools and therefore courses were “often taught by non-specialists with a weak grasp of the subject.”⁷⁵ Indeed, written evidence from the Alliance of Sector Skills Councils quoted research that showed students’ experience of IT at key stage 4 was “the biggest single factor in the drop in uptake of IT-related education beyond that level.”⁷⁶

57. Another problem identified in evidence we received was from Stuart Jones who stated that schools struggled to recruit physical scientists who also had teaching skills.⁷⁷ He believed that teachers’ “empathy and understanding” with students was the key to good learning.⁷⁸

58. The Welsh Government’s evidence acknowledged that despite incentives aimed at attracting the best quality students to train and teach STEM subjects, “there remains a critical lack of suitably qualified teachers within schools, particularly in maths.”⁷⁹ The Engineering Education Scheme Wales believed that it would “contribute significantly to raising standards and interest in STEM subjects if engineers were encouraged into teaching.”⁸⁰

⁷³ Estyn written evidence paragraph 14

⁷⁴ Institute of Physics in Wales written evidence page 3

⁷⁵ Software Alliance Wales written evidence section 2.2. Software Alliance Wales is a five-year European Social Fund Convergence project aimed at boosting the ICT and computer science industries in the convergence area of Wales

⁷⁶ Alliance of Sector Skills Councils written evidence page 1

⁷⁷ Stuart Jones written evidence page 1

⁷⁸ Record of Proceedings paragraph 101, Enterprise and Learning Committee, 10 November 2010

⁷⁹ Welsh Government written evidence page 7

⁸⁰ Engineering Education Scheme Wales written evidence page 3

59. Estyn told us that:

“In a time of change, support for teachers through first-class educational resources and professional development opportunities are key.”⁸¹

60. Tinopolis suggested that new online educational packages could be used by teachers to supplement their knowledge and experience, which pupils find both interesting and entertaining.⁸²

“In an environment where it is not always possible to recruit the ‘best’ talent for delivering learning, newer technologies such as Web 2.0 and social networking can be an important enabler for bringing the ‘best’ content (from the global market) directly to learners. Teachers can then act in more of a tutoring/mentoring capacity, where delivery of the core theory is originated globally.”⁸³

61. Tinopolis also argued that interventions at teacher level through continuous professional development (CPD) appeared to offer the most leverage on raising pupil attainments in STEM.⁸⁴ Q Chip Ltd believed that:

“Additional subject training and refresher courses should be a regular component of the teachers CPD programme, perhaps even offering sabbaticals in industry.”⁸⁵

62. In addition, Estyn identified a need for more subject-specific in-service training.⁸⁶ We agree. Wales needs the teaching competence in schools to inspire pupils in subjects such as chemistry and physics where they are currently not being taught by people who are trained and enthused in those areas.

63. We appreciate the significant challenges of recruiting and retaining good, qualified, science teachers, and the importance of

⁸¹ Record of Proceedings paragraph 18, Enterprise and Learning Committee, 10 November 2010

⁸² Record of Proceedings paragraphs 88-89 and 105, Enterprise and Learning Committee, 17 November 2010

⁸³ Tinopolis written evidence page 2

⁸⁴ Tinopolis written evidence page 2

⁸⁵ Q Chip Ltd written evidence page 3

⁸⁶ Estyn written evidence paragraph 14; Estyn supplementary evidence paragraph 5

training and updating them in how to make their subjects exciting and appealing to young people.

We recommend that the Welsh Assembly Government should publish a continuous professional development plan for teachers in Wales, including those in Welsh medium education, aimed at improving in-service training and updating for STEM teachers and heads of department, not only to enhance their subject knowledge but also their understanding of how to teach specific subject topics up to GCSE level at the very least.

For the longer term we recommend that the Welsh Assembly Government should produce definitive data on the quantity and quality of STEM teachers and develop measures for encouraging and recruiting high quality physics, chemistry and mathematics teachers where there is an identified need.

Teacher work placements

64. The Education Business Partnership (Careers Wales) argued that:

“Teacher placements enable teachers to remain ‘in touch’ and up to date with the latest developments in business and industry which is fundamental to their own motivation and their ability to enthuse and engage their students.”⁸⁷

65. WJEC also recognised the “advantages” of giving teachers the opportunity to obtain work experience in science-related workplaces.⁸⁸

66. While we understand these arguments we are also aware that releasing teachers from their school responsibilities can create difficulties in providing and financing cover.⁸⁹ The Education Business Partnership (Careers Wales) told us that:

“The take-up of teacher placements today suffers from the phenomenon of ‘rarely cover’.[...]. It suffers also, which is more real in my mind, from the fear of leaving a supply teacher in charge of those precious young people into whom you must get a subject-driven, inflexible, heavily assessed curriculum.

⁸⁷ Education Business Partnership written evidence paragraph 8

⁸⁸ WJEC written evidence section 5

⁸⁹ CollegesWales written evidence paragraph 3.6

Those are the reasons why we cannot join the two as successfully as we would like. However, our Careers Wales partnership with EngineeringUK establishes Wales's STEM credentials on a UK national platform. They take us seriously in London, and they look at what we do and say, 'I wish we had that'. For example, they say, 'I wish we had the Welsh baccalaureate'.⁹⁰

67. Written evidence from Tinopolis suggested that:

"Work experience placements should start sooner and last longer, and there should be partial subsidy for this work. We believe this approach could deliver strong gains in employability and commercial performance. Government, Academia and Industry need to work together in a supported environment to collectively 'raise the bar'.⁹¹

We recommend that the Welsh Assembly Government should contract the Education Business Partnerships (Careers Wales) to develop strategic partnerships between schools and industry in order to increase opportunities for teacher and lecturer placements or sabbaticals with STEM employers as part of teachers' continuous professional development.

⁹⁰ Record of Proceedings paragraph 165, Enterprise and Learning Committee, 10 November 2010

⁹¹ Tinopolis written evidence page 4

Links between education and STEM employers

Demand-led skills

68. We were keen to hear the views of STEM employers in Wales, particularly those in the industries identified by the Welsh Government's Economic Renewal Programme as priorities for growth.

69. BT stated:

“We (along with other companies in the technology sector) are very clear about what we are looking for from young people joining our business. We want people with an interest in technology or the exploitation of technology, good interpersonal skills and skills that will be used in the workplace (time management, project management etc).”

70. However, BT felt that companies in the technology sector were the “poor cousins to science, engineering and maths,” and that the current trend was one of creating a generation of *users* of technology as opposed to people who understood its workings and construction. The company stated:

“The GCSE and A-Level in IT offer little more than IT user skills and a general overview of the impact of technology - they are not preparing young people to progress into ‘hard’ technology courses at university where young people will develop the skills that will keep the UK at the leading edge of IT development and exploitation.”⁹²

71. Software Alliance Wales also stated:

“Pupils do not discover the distinction between ICT (Information Communication Technology) and CS (computer science), and remain ignorant of a potentially-attractive subject. By the time they find this out, they have often made choices that prevent them from pursuing the subject further.”⁹³

72. In supplementary evidence to us, Software Alliance Wales put this into context by saying that this was not a new phenomenon, and

⁹² BT Wales written evidence paragraphs 3 and 9a

⁹³ Software Alliance Wales written evidence page 3

neither was it unique to Wales.⁹⁴ The Sector Skills Council for business and information technology (e-skills) made the point that 53 per cent of computing graduates from Welsh higher education institutions who enter employment within six months of graduation are not in IT jobs. e-skills acknowledged that this may have benefits for non-STEM sectors, but also questioned whether “this type of loss in the final stages of the STEM educational artery” needed to be addressed.⁹⁵

We recommend that the Welsh Assembly Government should commission research on why STEM graduates do not progress into STEM jobs, and on whether this is an issue for concern or not.

73. Q Chip Ltd was concerned that in its experience:

“Engineers have a good grounding in maths, however biologists often lack the ability to perform basic calculations such as molarity, a very standard analysis that in the 1980s was taught at Chemistry GCSE level. We believe the problem lies with the lack of supporting mathematics modules for biologists (many of whom do not take maths at ‘A’ level) and we have observed conflicting methods for what should be standardised calculations.”⁹⁶

74. Written evidence from Tinopolis also stated:

“We feel there is scope for improvement in terms of FE and HE provision within the STEM field relevant to our industry. Invariably, we find that graduate or post-graduate employees require extensive re-training in technology related disciplines. The core problem here is that courses lag behind current industry best practice (inevitable in such a fast-moving field), and that graduates almost always lack sufficient experience in a ‘live’ working environment to fit productively into a commercial team from the outset.”⁹⁷

75. WJEC’s written evidence referred to the findings of the Wales Employment and Skills Board report in May 2010, which raised concerns about sectors such as environmental technologies that are

⁹⁴ Software Alliance Wales supplementary evidence page 1

⁹⁵ e-skills written evidence paragraph 3.1.3

⁹⁶ Q Chip Ltd written evidence page 2

⁹⁷ Tinopolis written evidence page 3

“rapidly advancing but Wales is not sharing in their growth.”⁹⁸ Written evidence from the Alliance of Sector Skills Councils also identified a shortfall in the number of people with expertise in emerging environmental technologies including installation and maintenance of micro-generation equipment.⁹⁹ This finding chimed with our July 2010 report on Generating Jobs in the Green Economy, which identified a major skills gap in that sector.

76. Skillset Cymru, the Sector Skills Council for the creative media, fashion and textiles industries, commented that Wales faced a skills shortage in areas such as digital convergence, new technologies, broadcast engineering and programme formatting.¹⁰⁰ The Higher Education Funding Council for Wales (HEFCW) also stated that there was “evidence of a degree of under-representation in some key STEM areas of vital importance to the Welsh economy.”¹⁰¹ Yet HEFCW went on to state that:

“While there is evidence of broad expressions of employer demand and a strong sense of the value placed on STEM graduates by employers at a UK level, hard labour market intelligence for Wales is in short supply.”¹⁰²

77. We therefore welcome the Deputy Minister’s comment that a formal audit of the future skills needed in Wales was being planned.¹⁰³

We recommend that existing good practice by some of the Sector Skills Councils should be extended so that there are more strategic partnerships between employers and educational institutions to align curricula and qualifications more closely and to better equip students with the knowledge and the skills required for STEM employment.

We further recommend that the Welsh Assembly Government should proceed in its proposals to commission a formal skills audit of the supply of and future demand for STEM skills in Wales so that the two sides can be better matched accordingly.

⁹⁸ WJEC written evidence section 6

⁹⁹ SummitSkills, Alliance of Sector Skills Council written evidence page 4

¹⁰⁰ Skillset Cymru written evidence paragraph 8

¹⁰¹ Higher Education Funding Council for Wales written evidence paragraph 3.1.5

¹⁰² Higher Education Funding Council for Wales written evidence paragraph 4.1.e

¹⁰³ Record of Proceedings paragraph 105, Enterprise and Learning Committee, 8 December 2010

Pupils' experience of STEM employment

78. It is important that students gain direct contact with STEM employers, such as through science ambassadors and workplace activities.¹⁰⁴ Evidence submitted by the Education Business Partnership (Careers Wales) listed a number of initiatives for developing learners' understanding of STEM.¹⁰⁵

79. Stuart Jones raised concerns about "one-off" events that had the power to excite pupils but which, if not sustained within the day-to-day curriculum, were ineffective in engaging students over a longer period.¹⁰⁶ The Education Business Partnership (Careers Wales) suggested that a way round that was to:

"Ensure that all learners have positive interventions year on year that build progressively and challenge their STEM learning and knowledge, and culminate in the commercial application of their STEM ideas."¹⁰⁷

80. BT Wales suggested a Wales-wide programme where STEM companies could release their workers to volunteer in schools for a number of days a year.¹⁰⁸ BT also stated that it supported schemes to make work experience "more meaningful and more inspiring to young people."¹⁰⁹

81. On the other hand, Tinopolis told us:

"We are a small company; we are not going to save the education system. It is tough out there. While we try to co-operate, and we try to be good neighbours to education establishments in our area, we do not have the time, the facilities or the cash to enter into those sorts of long-term

¹⁰⁴ Careers Wales West written evidence page 2

¹⁰⁵ Education Business Partnership written evidence paragraphs 9-11

¹⁰⁶ Stuart Jones written evidence page 2

¹⁰⁷ Record of Proceedings paragraph 185, Enterprise and Learning Committee, 10 November 2010

¹⁰⁸ Record of Proceedings paragraph 85, Enterprise and Learning Committee, 17 November 2010

¹⁰⁹ BT written evidence paragraph 13

arrangements. Most small companies will be in exactly the same position. It is just not what we were designed for.”¹¹⁰

82. We believe it is essential that there should be more productive and more sustainable links between STEM employers and educational establishments, from primary school level through to higher education, so that young people gain positive experiences of STEM professions that can challenge negative perceptions and stereotypes. Yet there also needs to be equity in the system so that young people in one part of the country - such as rural or poorer areas where there may be only a small hub of local employers - have the same broad opportunities as those in other areas. In the interest of social mobility, the system should not perpetuate existing networks or stereotypes.

83. We heard that some of the Sector Skills Councils such as e-skills¹¹¹ and Skillset¹¹² have a good track record in developing fruitful engagement between education and employers, but this is by no means the picture for others. We were alarmed by the findings of UK Commission for Employment and Skills research that 90 per cent of employers did not even know who their sector skills council was.¹¹³

84. We believe that a more strategic approach needs to be developed.

We recommend that the Welsh Assembly Government should work with the Sector Skills Councils and Careers Wales to develop a framework for a continuum of learning from the Foundation Phase onwards in which schools and employers can be linked together more effectively in providing stimulating programmes to complement the STEM curriculum, including high quality, meaningful work placements that can give young people a taste of the skills they will need to be productive and successful in the world of work.

¹¹⁰ Record of Proceedings paragraph 93, Enterprise and Learning Committee, 17 November 2010

¹¹¹ Record of Proceedings paragraphs 101-102, Enterprise and Learning Committee, 17 November 2010

¹¹² Record of Proceedings paragraph 42, Enterprise and Learning Committee, 8 December 2010

¹¹³ Record of Proceedings paragraph 45, Enterprise and Learning Committee, 8 December 2010

Further and higher education

85. Q Chip Ltd stated that it had “very good business and education links with the academic community,” which it attributed to a mature higher education network, the fact the company was based on intellectual property acquired from Cardiff University’s School of Engineering, and because it employed many local alumni.¹¹⁴ Yet the company also commented on the lack of practical skills among STEM graduates which meant they were “not ready for industry”:¹¹⁵

“Current degree courses have reduced the students’ exposure to practical training, which is often protocol biased. This does not prepare graduates for independent thinking...Sadly a degree course does not adequately prepare students for laboratory based careers...We have found that our new graduates are not adequately trained to assess practical risk.”¹¹⁶

We recommend that higher education degree courses should put greater emphasis on practical application and independent experimental work, and that assessment frameworks need to reflect this emphasis.

86. Tinopolis told us that its sector’s relationship with colleges, schools and higher education had “not been an easy one.” We were told that the expectations of the parties were very different and that some of the colleges that they had spoken to did not “speak the same language as us in terms of the skills that we believe need to be delivered.”¹¹⁷

87. BT Wales told us that while it had links with schools there was a “gulf” at the further and higher education levels. The company stated that:

“When the sector looks for young people to join its research and development centres, it consistently looks to education systems overseas where school and university provision produces young people with a strong grounding in the

¹¹⁴ Q Chip Ltd written evidence page 3

¹¹⁵ Record of Proceedings paragraph 119, Enterprise and Learning Committee, 17 November 2010

¹¹⁶ Q Chip Ltd written evidence pages 1-2

¹¹⁷ Record of Proceedings paragraph 25, Enterprise and Learning Committee 17 November 2010

processes and good practice that are required in R&D centres – skills that are certainly lacking in people leaving the school system and rarely adequately developed in the UK university system.”¹¹⁸

88. Written evidence from Software Alliance Wales stated that although Welsh higher education institutions produced about 1,200 graduates in ICT and computer science each year, a “significant proportion” move or return to England.¹¹⁹ The project also stated that:

“The success of Welsh higher education institutions (HEIs), coupled with the small size of the country brings challenges when dealing with larger companies with significant R&D activity and a presence in Wales. There are not many such companies, and hence there’s a low likelihood of finding ones that align with the expertise in the HEIs. So HEIs often have links with larger organisations based wholly outside Wales.”¹²⁰

89. When we asked them, Software Alliance Wales could think of only three examples of “significant and successful collaboration” between academic staff and industry: none of the companies involved was in Wales and two were not even in the UK.¹²¹

90. Cardiff University stated that in order to improve links between education and business and to improve the employability of STEM graduates, there should be an increased emphasis on work-based learning, sandwich schemes, internship programmes and entrepreneurship training.¹²²

91. We also heard concerns from witnesses about the lack of collaboration between Welsh universities themselves; they were perceived as often competing in bidding for funding for innovative projects in this field. For example, BT Wales was concerned about the lack of a digital hub in Wales; the Deputy Minister was concerned about the lack of research and development money attracted into Welsh higher education and the need to improve the quality of bids, particularly to maximise the opportunities available to support science

¹¹⁸ BT Wales written evidence paragraph 9b

¹¹⁹ Software Alliance Wales written evidence section 2.1

¹²⁰ Software Alliance Wales written evidence section 2.5

¹²¹ Record of Proceedings paragraph 35, Enterprise and Learning Committee, 17 November 2010

¹²² Cardiff University written evidence page 3

innovation, such as through the European Framework Programme FP7 funding, which will evolve into FP8.¹²³

We recommend that the Welsh Assembly Government should ensure that Wales capitalises on non-domestic funding opportunities so that higher education institutions can work with local authorities and with high-tech industries in their areas on joint bids to develop innovative projects aimed at encouraging the take-up of STEM in education and employment.

92. While there are examples of excellent practice by higher education institutions, we believe that more needs to be done to provide opportunities and facilities that can allow Wales to compete with other areas in the UK and abroad and so help to retain STEM skilled graduates in this country. We welcome the principle of the Welsh Government's economic renewal programme in focusing on high growth industries such as ICT. However, there is currently not sufficient incentive for academics to develop their links with industry: the current emphasis tends to be on promoting their research activities. As Software Alliance Wales pointed out, it may need intermediaries to foster and coordinate the relationship between education and industry to change the current culture within higher education,¹²⁴ a point we made in our 2009 report on the Economic Contribution of Higher Education. BT Wales suggested that the current "disjointed" conversations between academia and industry could be brokered by the Chief Scientific Adviser.¹²⁵

We recommend that higher education institutions and individual academics in Wales should be challenged to lever their academic STEM success into economic and educational areas through collaborative working with businesses and schools, and that the Chief Scientific Adviser for Wales should play the key role in joining up and providing quality control of different initiatives in this area.

¹²³ Record of Proceedings paragraphs 75 and 87, Enterprise and Learning Committee, 8 December 2010

¹²⁴ Record of Proceedings paragraph 47, Enterprise and Learning Committee, 17 November 2010

¹²⁵ Record of Proceedings paragraph 50, Enterprise and Learning Committee, 17 November 2010

Tying the STEMs together

The need for an overarching framework

93. In its written evidence Estyn stated that “a national education strategy, expanded to encompass all STEM subjects, is needed as a matter of urgency.”¹²⁶ It later told us that:

“Our main recommendations are that a national education strategy for improving standards needs to be developed, that further specific subject training is required for teachers and heads of department, and that training is needed to extend knowledge, not only in the subjects, particularly physics, but also in how to teach children in school.”¹²⁷

94. WJEC also argued for:

“A more integrated strategic STEM agenda for Wales ...[to]..inform future work across the inter-related areas of curriculum and qualifications development, continuing professional development for teachers and lecturers, and the provision of high quality learning resources in both languages.”¹²⁸

95. WJEC later told us that:

“In addition to that, we need a strategy framework for collaboration that would bring together educators, industry and relevant Government departments.”¹²⁹

96. The Education Business Partnership too believed that progress on STEM work could be enhanced by a “clearer policy steer” from the Welsh Government.¹³⁰ GE Aviation Services stated that STEM initiatives:

“Lack clarity and direction. It can be confusing for employers and there is a need for a single coordinating body.”¹³¹

¹²⁶ Estyn written evidence paragraph 2

¹²⁷ Record of Proceedings paragraph 12, Enterprise and Learning Committee, 10 November 2010

¹²⁸ WJEC written evidence section 6

¹²⁹ Record of Proceedings paragraph 19, Enterprise and Learning Committee, 10 November 2010

¹³⁰ Education Business Partnership written evidence paragraph 16

¹³¹ GE Aviation Services – Wales written evidence page 1

97. We welcome the statement in the Welsh Government’s written evidence that the new independent Science Advisory Council for Wales is working with the Chief Scientific Adviser for Wales on preparing a new Science Policy for Wales to address the issues of STEM education within both the formal curriculum and in extra-curricular science.¹³² Yet we were concerned to hear claims from witnesses that the bias of the Advisory Council is towards science and not across the rest of the STEM agenda.¹³³

98. We welcome the comments of the Chief Scientific Adviser for Wales¹³⁴ when he told us that he is working on achieving better representation from the SME (small and medium-sized enterprises) sector, but we believe there needs to be a better interface between the Science Advisory Council for Wales and the priority sectors identified in the Welsh Government’s Economic Renewal Programme.

We recommend that in taking forward its work the Science Advisory Council for Wales should also promote the other three STEM disciplines as well as closely engage with Welsh employers and industrialists in those sectors.

Role of the Chief Scientific Adviser and National Science Academy

99. Most witnesses to our inquiry welcomed the appointment of the Chief Scientific Adviser for Wales and the establishment of the National Science Academy.

100. Estyn and WJEC saw the role of the Chief Scientific Adviser as providing leadership and strategy and coordinating the action of the very many agencies working in the field.¹³⁵

101. The Education Business Partnership (Careers Wales) told us that:

“Given the plethora of organisations involved in STEM activities, the current overall picture can be confusing, giving the impression of scatter-gun activities, rather than a strategy where roles and outcomes are clearly assigned and stated.

¹³² Welsh Government written evidence page 10

¹³³ Record of Proceedings paragraph 198, Enterprise and Learning Committee, 8 December 2010

¹³⁴ Record of Proceedings paragraph 86, Enterprise and Learning Committee, 8 December 2010

¹³⁵ Record of Proceedings paragraphs 89-91, Enterprise and Learning Committee, 10 November 2010

There is a need to avoid duplication of effort, or STEM work is not as effective as it might be. Generally, STEM activities are most effective when the roles of partners are clearly defined, where they do not overlap, where activities are co-ordinated, where clear aims and objectives with measurable outcomes are set, and where activities are not standalone, but part of a continuum of learning, which benefits learners and, in the longer term, employers alike.”¹³⁶

102. BT Wales said it would welcome increased engagement with the Chief Scientific Adviser on the STEM agenda.¹³⁷ Yet the Engineering Education Scheme in Wales believed that the appointment of the Chief Scientific Adviser and the creation of the National Science Academy had “done little to help redress the balance within the STEM family, and the apparent adoption of engineering, as a junior partner, by science does not give engineering and manufacturing the status it deserves or needs to contribute to the stability and growth of the Welsh economy.”¹³⁸

103. The Alliance of Sector Skills Councils referred to “a possible lack of awareness” surrounding the work of the Chief Scientific Adviser and the National Science Academy.¹³⁹ The Association for Science Education Cymru also commented that “communication and implementation” on both developments had been “disappointing in its first year of activity.”¹⁴⁰

104. We agree organisations and initiatives need to be brought together for the improvement of the whole STEM agenda. We therefore see the role of the Chief Scientific Adviser and the National Science Academy as very much raising the profile of STEM in schools, the workplace and with society as a whole; promoting the take-up of STEM at all levels; and coordinating and possibly prioritising STEM programmes throughout Wales. As the Wales Institute of Mathematical and Computational Sciences argued, there is a need to “establish more clearly what kind of STEM activities really make the greatest difference

¹³⁶ Record of Proceedings paragraph 141, Enterprise and Learning Committee, 10 November 2010

¹³⁷ BT Wales written evidence paragraph 20

¹³⁸ Engineering Education Scheme in Wales written evidence page 3

¹³⁹ Alliance of Sector Skills Councils written evidence page 6

¹⁴⁰ Association for Science Education Cymru written evidence page 3

within the limited budget available.”¹⁴¹ To fulfil those roles, a true Academy will require the proper constitution, sustainable funding and clearly defined objectives. We trust that the Welsh Government’s promised evaluation of the National Science Academy by April 2011¹⁴² will address those issues.

We recommend that the Welsh Assembly Government should, through the Chief Scientific Adviser, develop and monitor performance against an action plan to promote the whole STEM agenda in Wales, through setting clear long-term objectives, and shorter-term priorities and targets.

We also recommend that in formulating his future work programme, the Chief Scientific Adviser should be charged with taking forward the recommendations of our report.

¹⁴¹ Wales Institute of Mathematical and Computational Sciences written evidence page 4

¹⁴² Record of Proceedings paragraph 34, Enterprise and Learning Committee, 8 December 2010

Conclusions

105. STEM skills are important to the education of young people and to the development of a prosperous and sustainable knowledge-based economy in Wales. The Welsh Government's objective should therefore be to encourage the take-up of STEM from an early age, sustain a sufficient stream of appropriately qualified students to enter university, and enable STEM graduates to progress into careers that are important to the economic development of Wales.

106. The Minister identified the main challenges to be faced as:

“Issues in terms of recruitment between industry and schools and issues about the perception of STEM careers, such as engineering within schools. Those are real challenges, and they are things that we are very focused on.”¹⁴³

107. We heard of many excellent initiatives taking place across Wales, yet the pathway of STEM learning and into STEM-related employment suffers from a number of problems – and has done for some considerable time.

108. Yet we would warn against too simplistic an acceptance of the need for “more STEM skills” as it is the alignment of the supply and demand for skills that can meet the future needs of the economy that should be the key objective.

109. Our inquiry has left us deeply concerned about a number of issues: first, STEM subjects still suffer from poor perceptions, not only among pupils but also teachers and school authorities. There is therefore a need to improve perceptions of STEM so that the subjects are more appealing; the scientists, technologists, engineers and mathematicians need to promote themselves differently.

110. Secondly, pupil performance in STEM subjects, particularly in the secondary sector, can also be poor. We were particularly concerned with evidence that suggested it is often the tight timetable for students' options and lesson times that affects the ability of students to study the practical elements of STEM subjects. We were also struck by the need to address differences in STEM take-up between girls and

¹⁴³ Record of Proceedings paragraph 115, Enterprise and Learning Committee, 8 December 2010

boys and to promote equality of opportunity where it is currently deficient.

111. Thirdly, and closely linked to pupil performance, we heard that the quality of teaching and leadership in STEM subjects is often wanting. We heard that while resources and materials within schools may have improved, the two key weaknesses in the system are first the recruitment and retention of teachers who have both the scientific expertise and the aptitude to teach and secondly, the continuous professional development of teachers to ensure they keep on top of their subject and their pedagogy.

112. Fourthly, employers told us they perceived a lack of basic skills in their new recruits, made worse by the fact that the best candidates are not necessarily going into STEM related employment. We also heard that graduates are not “ready for industry,” particularly in terms of their practical and “soft” skills.

113. We believe it is important that Wales’s young people acquire general life skills and social skills, but they also need to be prepared for the world of work. That means developing the right competencies to support their future careers. Our recommendations are therefore aimed at increasing the involvement of STEM employers in school work to support and update both teachers and students alike; reciprocally, at enabling more teachers to spend time in STEM-related workplaces; at ensuring that young people have the right opportunities, and the right advice to allow them to make early and informed choices that will help them in their future careers; and at increasing the involvement of employers in shaping the strategy and content of education and training to ensure Wales has a workforce with the relevant knowledge and skills to advance its future prosperity.

114. All that requires more productive and more sustainable collaborations between the Welsh Government, employers and Wales’s educational institutions – from primary school to higher education. In particular, it demands better cross-departmental links to coordinate the skills agenda in Wales with the development of the curriculum in schools and in further and higher education.

115. We do not underestimate the challenges facing Wales, and we appreciate that success will not happen overnight. We are also convinced that the Welsh Government is committed to make progress

in these areas. The Minister's intention, for example, to focus on "quality and depth" in the curriculum¹⁴⁴ as opposed to ever wider learner choice was particularly refreshing to hear. There are reasons, therefore, to be optimistic, and we look to the newly appointed Chief Scientific Adviser for Wales and the National Science Academy to take forward the STEM agenda in a focused and targeted way.

¹⁴⁴ Record of Proceedings paragraph 168, Enterprise and Learning Committee, 8 December 2010

Witnesses

The following witnesses provided oral evidence to the Committee on the dates noted below. Transcripts of all oral evidence sessions can be viewed in full at <http://www.assemblywales.org/bus-home/bus-committees/bus-committees-scrutiny-committees/bus-committees-third-els-home/bus-committees-third-els-agendas.htm>

10 November 2010

Estyn

WJEC

Stuart Jones, St Alban's Roman Catholic School, Pontypool

Education Business Partnership (Careers Wales)

17 November 2010

BT Wales

Tinopolis

Software Alliance Wales

GE Aviation Services – Wales

Q Chip Ltd

8 December 2010

Welsh Assembly Government

Engineering Education Scheme Wales

List of written evidence

The following people and organisations provided written evidence to the Committee. All written evidence can be viewed in full at http://www.assemblywales.org/bus-home/bus-committees/bus-committees-scrutiny-committees/bus-committees-third-els-home/bus-committees-third-els-inquiry/el3_inq_stem/el3_inq_stem_responses.htm

Organisation

Alliance of Sector Skills Councils

Association of School and College Leaders Cymru

Association of Teachers and Lecturers Cymru and Association for College Management / Association of Managers in Education

Association for Science Education Cymru

British Waterways

Cardiff University

Careers Wales West

Jon Cartmell, Yale College, Wrexham

CollegesWales

EngineeringUK

e-skills uk

Professor Simon Haslett, University of Wales

Higher Education Funding Council for Wales

Institute of Physics in Wales

Royal Society of Chemistry

Skillset Cymru

Techniquet

Undeb Cenedlaethol Athrawon Cymru

Wales Institute of Mathematical and Computational Sciences