Wales Institute of Mathematical and Computational Sciences

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28th October 2010.

WIMCS response to the Enterprise and Learning Committee Inquiry into STEM skills

Introduction

WIMCS welcomes this opportunity to comment on the development of STEM skills. It does so from the perspective of an organisation set up in 2006 by its partner institutions supported by £5m of HEFCW funding predominantly allocated to new academic posts with the key objectives of:

1. Enhancing the standing of Mathematics and Computation in Wales
2. Enhancing links with industry commerce and business
3. Generating substantial research funding
4. Providing a forum for education and public awareness of the Mathematical sciences.

In addition to its own outreach activities, WIMCS was selected in 2009 to manage the Welsh Spoke of the National HE STEM Programme for England and Wales that is led by the University of Birmingham.

The views expressed in this document are the views of the WIMCS Director and his staff, and not necessarily those of the partner institutions.

Response

WIMCS shares the concerns identified in the Roberts report (see 4.2.3 in NSA Scoping Study)

- Quality of science teachers
- Number obtaining good science GCSE results
- Number choosing STEM subjects in post 16 and higher education
- Proportion of better qualified students pursuing R&D careers
- Proportion of minority ethnic and women participants taking STEM subjects in higher education.

Evidence

In appendix A attached, WIMCS has assembled what it believes to be some key statistics. These have been obtained from the 'General Teaching Council for Wales Statistics ref http://www.gtcw.org.uk/gtcw/index.php/en/publications/teacher-statistics and http://www.jcq.org.uk/national_results/alevels/.

A.1 Science Teachers

A.1 illustrates that in Wales in 2009:

65% Maths teachers were subject trained
43% Chemistry teachers were subject trained
38% Physics teachers were subject trained.

WIMCS' conclusion is that in all 3 subjects there is a clear shortfall as evidenced in A.2 below. The shortfalls contribute to the take up levels of STEM subjects which in turn perpetuates the shortfalls.

A.2 Numbers choosing STEM subjects post 16

A.2 illustrates the numbers taking Maths, Further Maths, Physics and Chemistry at A level in 2009:

8% of students chose Maths in England and Wales
1.3% students chose Further Maths in England and 0.7% in Wales*
5% students chose Chemistry in England and Wales
3% students chose Physics in England and Wales

*The difference has been consistent over the past 5 years.

The conclusions drawn by WIMCS are that:

1. If these low figures on STEM subject choice were to continue, it is difficult to see how England and Wales will be able to claim to be in the vanguard of technological development. It may even be that they will not be able to sustain their current technological level.
2. In Wales significantly fewer students study Further Maths.
3. More effort and resources need to be put into understanding the low take up, and then on determining how to remove obstacles and ultimately into how to persuade more students to choose STEM subjects.

A.3 Male/Female choice of STEM subjects at A-level

A.3 illustrates the difference in male/female choices of STEM subjects in the UK

WIMCS's conclusion is that there continue to be substantial gender differences among those opting to take STEM subjects at A-level.
e.g. In 2009 choices by male/female (as percentages resp. of gender totals) were: Maths 11%/6%; Furth. Maths 1.8%/0.7%; Chemistry 5.6%/4.5%; Physics 5.9%/1.4%

STEM issues that need to be addressed

WIMCS agrees as in section 7.2 in NSA scoping study that the issues that need to be addressed include:

- Creating positive attitudes towards STEM subjects and careers
- Providing a relevant, attractive and challenging curriculum
- Providing accessible modern fit for purpose learning facilities
- Providing a skilled up to date and enthusiastic teaching and guidance workforce
- Encouraging participation in STEM related higher education.

WIMCS also believes that provision to challenge and enthuse 'more able and talented' pupils is essential (section 7.6.3)

Examples of responses to address these issues

WIMCS would point to some of the activities it has been involved with:

1) School Roadshows for Wales in Maths for years 8/9 and years 10/11 students (EPSRC grant 2008 £130K – partner Science made Simple) - aiming to create positive attitudes in Maths.

2) Translation of More Maths Grads Career resources into Welsh – and distribution of these bilingual resources - aiming to create positive attitudes towards Maths and specifically Mathematically related career opportunities.

3) Further Maths Support Programme (first year of a 3 year £440k programme has been funded by WAG, also supported by Mathematics in Education and Industry which runs the Further Maths Support Programme in England – aiming at closing the gap in numbers choosing to study Further Maths at A level between Wales and England – several UK universities e.g. Warwick now insist that students wishing to study for Maths Degrees have Further Maths and Maths at A level.

4) Provision at Universities in Wales of Mathematics Master Classes. Bangor University has had Maths Master Classes for many years, and the University of Glamorgan has offered a range of Maths specific outreach including Masterclasses for several years. WIMCS has organised for the last 2 years the Maths Masterclasses at Swansea University and Swansea Metropolitan University (alternate Saturday mornings in Spring term), and has supported the Aberystwyth Maths Club (activity aimed at 'more able and talented').
WIMCS experience is the demand is there. Places are oversubscribed at Swansea, and Glamorgan have set up separate Masterclasses for different year groups to cope with the demand.

Further responses that WIMCS suggest

WIMCS believes that for Wales (and the UK) to continue to be technologically and scientifically leading the Government needs to invest resources in persuading the population as a whole and young people in particular to embrace Science. It seems to WIMCS that there is no single way to achieve this. What is clear is that narrow curricula and exam result oriented teaching will not produce the excitement and

enthusiasm that could dramatically increase the percentages of students wishing to study Maths, Engineering and the Sciences at A level and beyond.

In addition to its existing outreach activities and programmes:

a) WIMCS supports more resources being put into STEM teacher CPD. It would like to see initiatives such as the Institute of Physics Coordinator Scheme running in England and 3 pilot areas in Wales taken pan-Wales.
http://www.iop.org/education/teacher/support/network/index.html.

b) WIMCS supports measures to address the gender differences in STEM subject take up. Female role models is clearly an issue, and positive action to find suitable examples of women, working in teaching, academia, commerce and industry, willing to participate in STEM promotion projects, might be one solution.

c) WIMCS supports more resources being directed towards supporting STEM academics and industrialists to share their enthusiasm with both the general public (media/lectures) and young people (STEM ambassadors/masterclasses).

d) WIMCS believes that Government (UK/WAG) could work with media and with e.g. Open University to produce programmes of the calibre of the Big Bang Series to explain how things work e.g. Jet Engines, Power Stations, Mobile Phone Communication, Digital TV that could be used in schools followed by 'practical' follow up work exploring the Scientific concepts involved.

Summary

WIMCS supports the NSA initiative if it encourages rather than hampers the considerable number of local initiatives already ongoing in Wales that aim to ensure greater take up of STEM subjects. It believes that the enthusiasms of organisations and individuals need to be incorporated into the NSA (WAG) policies. Support for successful schemes, e.g. to roll them out pan-Wales, from NSA/WAG should be part of a co-ordinated strategy, which looks to avoid duplication.

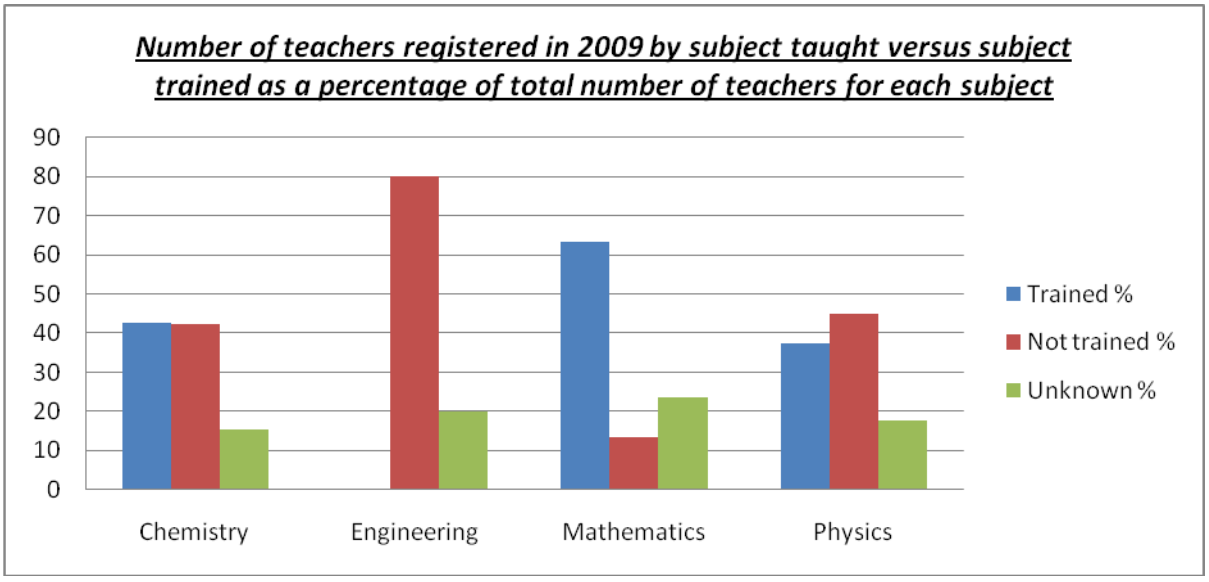
However simply supporting existing schemes is probably not enough. WIMCS believes that there needs to be NSA/WAG led activity that brings together the thinking of the many groups involved – teachers, industrialists, academics, county science advisers, politicians etc – to establish more clearly what kind of STEM activities really make the greatest difference (within the limited budget available). Generating a positive attitude to STEM subjects in the general population and more particularly among the young is very important, but it may be that illustrating career structures and allowing hands on experience of working in a 'high-tec' environment is even more so. WIMCS believes that one of the immediate goals should be to identify ways to change STEM attitudes positively both in terms of choosing study courses and careers that can be continued on a financially sustainable basis.

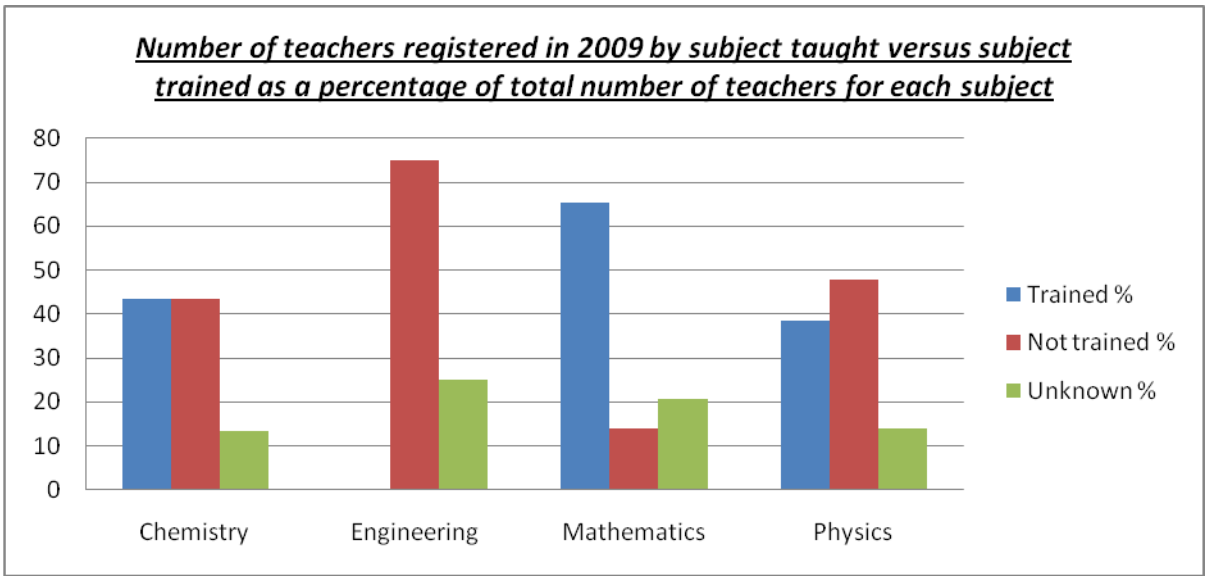
In conclusion WIMCS fully supports the policy of developing STEM skills, and would like to continue to be involved in the NSA initiative.

Appendix A.1 ref http://www.gtcw.org.uk/gtcw/index.php/en/publications/teacher-statistics

Number of teachers registered by subject taught versus subject trained

Subject	Year	Total No. of teachers	No. trained	% of Total	No. not trained	% of Total	Trained unknown	% of Total
Chemistry	2008	441	188	42.6	186	42.2	67	15.2
	2009	446	193	43.3	194	43.5	59	13.2
Engineering	2008	10	0	0	8	80	2	20
	2009	8	0	0	6	75	2	25
Mathematics	2008	1481	937	63.3	198	13.4	346	23.4
	2009	1498	979	65.4	209	14	310	20.7
Physics	2008	397	149	37.5	178	44.8	70	17.6
	2009	405	156	38.5	193	47.7	56	13.8





From the bar charts, we can see that:

- For Chemistry, the percentages of trained and untrained teachers are roughly the same.
- For Engineering, there are no trained teachers known.
- For Mathematics, the majority of teachers are known to be trained.
- For Physics, the percentage of untrained teachers is slightly higher than trained teachers.

Appendix A.2 ref http://www.jcq.org.uk/national_results/alevels/

Country	Year	School	Total No. Sat	% of Total	% of As
England	2005	717284	48058	6.7	39.9
	2006	741565	51168	6.9	43.0
	2007	740986	54833	7.4	43.2
	2008	757756	59105	7.8	43.4
	2009	773860	66552	8.6	44.8
Wales	2005	35466	2589	7.3	43.6
	2006	36250	2465	6.8	44.1
	2007	36066	2741	7.6	43.9
	2008	37063	2928	7.9	43.4
	2009	38598	3165	8.2	43.5

Table 1: numbers taking GCE Mathematics and the percentage of students achieving A grade each year as a percentage of total number sat (mixed gender, all awarding bodies)

Country	Year	School Population	Total No. Sat	% of Total No. Sat	% of As
England	2005	703375	5627	0.8	58.1
	2006	772222	6950	0.9	56.9
	2007	755100	7551	1.0	56.7
	2008	794818	8743	1.1	57.5
	2009	774846	10073	1.3	58.1
Wales	2005	37200	186	0.5	54.8
	2006	35200	176	0.5	49.4
	2007	37200	186	0.5	55.9
	2008	39000	195	0.5	52.3
	2009	35714	250	0.7	55.6

Table 2: numbers taking GCE Further Mathematics and the percentage of students achieving A grade each year as a percentage of total number sat (mixed gender, all awarding bodies)

Country	Year	School Population	Total No. Sat	% of Total No. Sat	% of As
England	2005	712959	34935	4.9	29.0
	2006	737204	36123	4.9	30.9
	2007	744041	36458	4.9	32.0
	2008	754220	37711	5.0	33.2
	2009	785000	38465	4.9	34.0
Wales	2005	35414	2054	5.8	30.7
	2006	36702	2092	5.7	29.6
	2007	36000	1980	5.5	32.0
	2008	36946	2069	5.6	31.7
	2009	38386	2188	5.7	33.8

Table 3: numbers taking GCE Chemistry and the percentage of students achieving A grade each year as a percentage of total number sat (mixed gender, all awarding bodies)

Country	Year	School Population	Total No. Sat	% of Total No. Sat	% of As
England	2005	726229	25418	3.5	28.3
	2006	727353	24730	3.4	29.3
	2007	731000	24854	3.4	30.8
	2008	751294	25544	3.4	31.9
	2009	782647	26610	3.4	32.2
Wales	2005	35868	1363	3.8	28.1
	2006	36474	1386	3.8	26.4
	2007	35757	1323	3.7	25.9
	2008	36829	1289	3.5	25.6
	2009	38789	1474	3.8	28.1

Table 4: numbers taking GCE Physics and the percentage of students achieving A grade each year as a percentage of total number sat (mixed gender, all awarding bodies)

Appendix A.3 ref http://www.jcq.org.uk/national_results/alevels/

Subject	Year	Gender	School Population	Total Number Sat	% of Total Number
Mathematics	2005	Male	359549	32719	9.1
		Female	420375	20178	4.8
	2006	Male	370576	34093	9.2
		Female	437780	21889	5.0
	2007	Male	367714	36036	9.8
		Female	437400	24057	5.5
	2008	Male	379598	38719	10.2
		Female	446103	25874	5.8
	2009	Male	391409	43055	11.0
		Female	459688	29420	6.4
Further Mathematics	2005	Male	436500	5238	1.2
		Female	423750	1695	0.4
	2006	Male	364714	5106	1.4
		Female	432800	2164	0.5
	2007	Male	370400	5556	1.5
		Female	463200	2316	0.5
	2008	Male	372059	6325	1.7
		Female	461000	2766	0.6
	2009	Male	399444	7190	1.8
		Female	469000	3283	0.7
Chemistry	2005	Male	357655	19671	5.5
		Female	426222	19180	4.5
	2006	Male	370782	20393	5.5
		Female	437133	19671	4.5
	2007	Male	367455	20210	5.5
		Female	436413	20075	4.6
	2008	Male	381536	21366	5.6
		Female	451422	20314	4.5
	2009	Male	391429	21920	5.6
		Female	457133	20571	4.5
Physics	2005	Male	359377	21922	6.1
		Female	413133	6197	1.5
	2006	Male	369103	21408	5.8
		Female	425714	5960	1.4
	2007	Male	368224	21357	5.8
		Female	436357	6109	1.4
	2008	Male	378293	21941	5.8
		Female	439643	6155	1.4
	2009	Male	388102	22898	5.9
		Female	467000	6538	1.4