

# IOP Institute of Physics

## Institute of Physics submission to the review of the Royal Society of Edinburgh 'Tapping all our Talents' report

27 April 2018

The Institute of Physics (IOP) welcomes the opportunity to submit evidence to the Tapping all our Talents review. The IOP is committed to addressing gender issues in STEM and operates a number of programmes in Scotland, and the rest of the UK, that aim to increase the representation of women and girls in physics in school, further education, higher education and employment.

### Section 1: In brief

#### **Q1 Do you believe progress has been made towards achieving gender equality in the STEM workplace in Scotland since 2012?**

Yes, there is evidence of progress in some areas. For example, the proportion of female academic staff in UK university physics departments has risen from a low of 14% in 2006 to 18% in 2014/15.<sup>1</sup> While this remains far below the UK HE all-subject average of 48%, the upward trend is encouraging. Over the same period the proportion of female professors in UK university physics departments has risen from 5% to 11% and is now greater than that for other subjects such as maths and chemistry. This proportion is still well below the UK HE sector average of 23%. Within the STEM workforce in industry, the WISE campaign reported that 'women make up 23% of those in core STEM occupations in the UK and 24% of those working in core STEM industries'.<sup>2</sup> Again, this proportion is on a steady but slow upward trend.

As encouraging as these upwards trends are, the overall proportion of women in physics remains low and there is a lot of work to be done at all levels, before gender equity is achieved in STEM. Discouragingly, the proportion of female entrants to Higher physics has fallen from a 12-year high of 29.1% in 2013 to 25.9% in 2017.

#### **Q2 If yes, what action(s) do you believe have had the greatest impact on improving gender equality in STEM in Scotland? (List maximum of 3).**

- Educating influencers on students in the education system about bias and stereotyping.
- Family friendly working policies, such as those advocated by the IOP's Project Juno<sup>3</sup>, and increased overall awareness of gender equality issues through extensive engagement.

#### **Q3 Where you do not believe progress has been made, or could be improved upon, what do you believe have been the key limiting factors? (List maximum of 3).**

- At Highers level the proportion of girls studying physics has fallen over recent years.

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<sup>1</sup> HESA data.

<sup>2</sup> <https://www.wisecampaign.org.uk/resources/2017/10/women-in-stem-workforce-2017>

<sup>3</sup> <http://www.iop.org/policy/diversity/initiatives/juno/index.html>

The IOP reports 'It's Different for Girls'<sup>4</sup> and 'Closing Doors'<sup>5</sup> indicated that to increase STEM participation, we need to look beyond the science department, to the different experiences that girls and boys are subject to during their time in education and how that impacts on their subject choices.

- The gender pay gap.

One of the features associated with the gender pay gap is the differential levels of employment in highly-paid sectors such as those related to science and engineering.<sup>6</sup> This is particularly true in physics. While graduate earnings surveys consistently place physics graduates well above average<sup>7</sup> and physics-based businesses in Scotland support a significant number of very high productivity jobs<sup>8</sup>, physics education and employment is well below average when it comes to gender parity.<sup>9</sup>

**Q4 Which of the recommendations made in the 2012 Tapping All Our Talents report do you believe should be prioritised going forward? (List maximum of 3).**

Achieving the aim of gender equity in STEM will take a concerted and wide-ranging programme of activity, in schools, universities, the workplace and society more broadly. The 2012 report recommended 'a national strategy for Scotland'. This recommendation has been taken forward, in part, through the STEM strategy,<sup>10</sup> which has a focus on gender issues in STEM. The priority now must be the effective implementation of this strategy.

**Q5 What further recommendations (if any) would you make to policy-makers, educators or employers to tackle gender inequality in STEM in Scotland? (List maximum of 3).**

There is a strong evidence base<sup>11</sup> for what works in engaging girls with physics at schools level and this should be central to all programmes and initiatives with this focus.

## Section 2: In detail

### Women in STEM in Scotland 2018

**Q6 What lessons do you believe have been learned from initiatives undertaken since 2012 to tackle gender inequality in the STEM workforce across the public, academic and/or industry sectors? Examples of good practice would be useful.**

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<sup>4</sup> IOP, 2012. It's Different for Girls

[http://www.iop.org/education/teacher/support/girls\\_physics/different/page\\_61620.html](http://www.iop.org/education/teacher/support/girls_physics/different/page_61620.html)

<sup>5</sup> IOP, 2013. Closing Doors [http://www.iop.org/education/teacher/support/girls\\_physics/closing-doors/page\\_62076.html](http://www.iop.org/education/teacher/support/girls_physics/closing-doors/page_62076.html)

<sup>6</sup> HESA, EngineeringUK data

<sup>7</sup> DELHE <https://www.hesa.ac.uk/data-and-analysis/students/destinations>

<sup>8</sup> CEBR, 2017. The role of physics in supporting economic growth and national productivity in Scotland [http://www.iop.org/publications/iop/2017/file\\_68806.pdf](http://www.iop.org/publications/iop/2017/file_68806.pdf) The report shows that 199,000 people are directly employed in physics-based businesses in Scotland, representing 7.9% of the workforce, and that the sector indirectly generates a further 323,000 jobs. Physics-based industries in Scotland generate £43.5 bn in turnover, which rises to £94.6 bn when indirect effects are considered. A person employed in physics-based industries contributed an average of £77,725 a year in value added. This is markedly above both the manufacturing and construction sectors' average labour productivity levels, which averaged £66,437 and £45,061.

<sup>9</sup> BIS, 2013. Professor John Perkins' Review of Engineering Skills

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/254885/bis-13-1269-professor-john-perkins-review-of-engineering-skills.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/254885/bis-13-1269-professor-john-perkins-review-of-engineering-skills.pdf)

<sup>10</sup> Scottish Government, 2017. STEM education and training strategy for Scotland

<http://www.gov.scot/Publications/2017/10/1386>

<sup>11</sup> IOP, 2017. Improving Gender Balance [http://www.iop.org/publications/iop/2017/file\\_69171.pdf](http://www.iop.org/publications/iop/2017/file_69171.pdf)

Some organisations have learned that they need to embed diversity and inclusion across all of their structures. An example of good practice is the IOP's Project Juno, which has been put in place to recognise and reward physics departments, schools, institutes and organisations that can demonstrate they have taken action to address gender equality in physics and to encourage better practice for all staff.

A lesson that is perhaps still to be learned is the need for a long-term strategy of engagement with young people to challenge perceptions and convince more students that they are welcome in the world of science. One-off events and activities are welcome but have limited influence on young people's decisions regarding their future. Programmes which emphasise continued engagement, and in particular look to help build science capital through teachers, parents and other influencers, are far more successful in changing aspirations than a focus on one-off visits and role models 'parachuted' into classrooms.<sup>12</sup>

**Q7 In 2018's economic, political and social context, what do you consider to be the key influencers (positive and negative) on gender equality in STEM in Scotland?**

Issues and barriers tend to be subject-specific, rather than common to all STEM subjects equally. For girls, the challenges of low participation and progression affect physics, computing, engineering and maths (in varying degrees of intensity) more than other subjects. It is important to make this distinction in any work to engage young people in science so as to best identify and focus efforts on where actual problems exist.

Many women and girls, receive a number of negative messages which reinforce their decision to not pursue science, including the message that 'science is not for you'. This is reinforced in everything from the language that is used in the classroom,<sup>13</sup> to the way that scientists and science are represented on television, to the kinds of people they see in positions of influence in science. Related to this is the often communicated message that 'science is too hard' and that science is 'perfect', needing experts to understand it, reinforced by the overused and misleading trope of the 'genius scientist'. Physics in particular suffers from this perception.

**Q8 To what extent do you believe that the issue of gender inequality in STEM is being recognised as a priority and to what extent do you believe that rhetoric is being met with action?**

The issues around gender in STEM have been a central part of community discussions for many years, and in recent times they have had a high profile within governments and wider society. Within the physics community there are a number of established programmes and initiatives that aim to redress the imbalance, including the IOP's Project Juno.

The 'Science, Technology, Engineering and Mathematics - Education and Training Strategy for Scotland'<sup>14</sup> places a high priority on improving the gender balance in STEM, including through a pledge to embed the learning from the successful Improving Gender Balance Scotland (IGBS) project<sup>15</sup> into the work of the government.

## Education

**Q9 What do you believe should be done to encourage more girls and young women to engage with STEM subjects in early years, primary and secondary education?**

The IOP runs a number of programmes across the UK and Ireland aimed at increasing the participation of girls in physics and has conducted research into the barriers to girls'

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<sup>12</sup> IOP, 2014. Raising Aspirations in Physics [http://www.iop.org/publications/iop/2014/file\\_64466.pdf](http://www.iop.org/publications/iop/2014/file_64466.pdf)

<sup>13</sup> IOP, 2015. Opening Doors [http://www.iop.org/education/teacher/support/girls\\_physics/reports-and-research/opening-doors/page\\_66438.html](http://www.iop.org/education/teacher/support/girls_physics/reports-and-research/opening-doors/page_66438.html)

<sup>14</sup> Science, Technology, Engineering and Mathematics - Education and Training Strategy for Scotland <http://www.gov.scot/Publications/2017/10/1386>

<sup>15</sup> [http://www.iop.org/education/teacher/support/girls\\_physics/igb\\_scotland/page\\_66766.html](http://www.iop.org/education/teacher/support/girls_physics/igb_scotland/page_66766.html)

participation. Gender stereotypes shape self-perception, affect wellbeing and attitudes to relationships, as well as influencing participation in the world of work. In a school environment they can affect a young person's classroom experience, academic performance and subject choice.

IOP research shows that work to tackle any gender imbalance in a school must be regarded as a whole school issue, and all strands of gender imbalance must be tackled together, as well as working with teachers of the sciences and with girls. It is now clear that the low participation of girls is more likely about attitudes to gender than attitudes to physics. Above all, it should not be seen as a problem with girls themselves, but with how their expectations have been shaped based on their gender.

Two IOP studies, 'It's Different for Girls' and 'Closing Doors', both used the National Pupil Database to explore why some schools in England were more successful than others at encouraging girls in STEM. For example, girls are almost four times more likely to go on to do A-level physics if they come from an independent girls' school rather than a state co-ed school. The equivalent ratio for boys is only two, showing that progression rates are indeed different for girls. Schools that have a less/greater than national average gender imbalance in a subject like physics are more likely to have less/greater than average gender imbalance in the other direction in other subjects like psychology and art. These reports both highlighted the effect of the different experiences that girls and boys are subject to during their time in education and how that impacts on their subject choices.

The IOP, in partnership with Skills Development Scotland and Education Scotland operates the IGBS project: a 3-year pilot project that aims to identify and address issues around gender and subject/career choice. One of the strengths of the project is that it embeds itself within the school and at different levels within the school (e.g. teachers, students, senior leaders, careers advisers). Changing gender biases requires sustained, long-term action and this approach enabled the project to have a wider-reaching impact than if it just focused on one group. Schools are often concerned about overcrowding of the curriculum and can be reluctant to take on additional work. However, participating schools generally felt that IGBS had taken an appropriate approach, by focusing on how gender balance projects can be built in as a cross-cutting theme rather than requiring additional activities. The Scottish Government has committed to embedding the learning from this project into its strategy.

Building on the IOP report 'Opening Doors'<sup>16</sup> and the nine essential features of good practice it identified, the IOP has completed a successful pilot of a gender equality kitemark for secondary schools in England. The kitemark could be adopted in Scotland, for both primary and secondary schools, by combining the learning from IGBS and the pilot.

**Q10 What innovative or impactful practice do you know of or believe should be taking place in universities and colleges to tackle issues of gender disparities in STEM subjects? What do you think can be done to embed STEM gender equality thinking across universities and colleges?**

As noted previously, the IOP's Project Juno, which is synchronous with the Athena SWAN Charter, has been successful in recognising and rewarding physics departments in universities that can demonstrate they have taken action to address gender equality and to encourage better practice for both women and men. There are currently three Juno Champions in Scotland.<sup>17</sup>

## **Cultural Change**

**Q11 In what ways do you believe industry can lead by example to tackle inequality within workplace culture?**

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<sup>16</sup> IOP, 2015. Opening Doors [http://www.iop.org/education/teacher/support/girls\\_physics/reports-and-research/opening-doors/page\\_66438.html](http://www.iop.org/education/teacher/support/girls_physics/reports-and-research/opening-doors/page_66438.html)

<sup>17</sup> [http://www.iop.org/policy/diversity/initiatives/juno/supporters/page\\_42627.html](http://www.iop.org/policy/diversity/initiatives/juno/supporters/page_42627.html)

The IOP's Project Juno encourages organisations to gather and reflect on their own data, to work to their own set of priorities (rather than a pre-agreed checklist), in order to address their own issues for change. The IOP itself aims to lead by example, being fully inclusive and acting to ensure all members or potential members can participate fully in its activities.

In July 2015 the IOP undertook a survey<sup>18</sup> of its UK membership to understand their diversity profile. This survey has provided valuable information that will help us continue our commitment to make our services accessible to all, and to implement policies and practices that are fair, inclusive and effective. We also published information about the gender make-up of our governing Council and Committees, awards and prizes and other indicators, demonstrating our own progress on gender equality.

**Q12 What do you believe are the most effective ways to challenge and change deep-rooted attitudes and institutional culture in order to improve gender equality in STEM?**

A requirement of Juno is to implement equality training for everyone involved in teaching and learning in the physics department, including postgraduate demonstrators. Many physics departments are now implementing not only equality training but also unconscious bias training for all staff and students (including undergraduates) and making this mandatory to ensure that everyone in the department is aware of expectations and necessary behaviours. In 2017, the IOP introduced a new Juno principle on professional conduct and all those participating in Juno now have to demonstrate that they are meeting minimum standards on professional conduct, values, and tackling harassment and bullying.

**Q13 How do you suggest culture change can be measured in a meaningful way?**

The measurement of success must be outputs and outcomes, rather than inputs and strategies. This should be at the national level and also at the level of specific projects.

There are a number of measures that are already part of standard data collection that would act as simple proxies for progress towards gender equity, for example:

- Numbers of girls choosing physics at Higher
- Number of women professors
- Number of women involved in senior management positions in universities/companies with a STEM background
- Number of women winning research grants / prestigious prizes in STEM

**About the Institute of Physics**

The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all. We have a worldwide membership ranging from those early in their career or in academic or technical training to those at the top of their fields in academia, business, education and government. Our purpose is to gather, inspire, guide, represent and celebrate all who share a passion for physics. And, in our role as a charity, we aim to ensure that physics delivers on its exceptional potential to benefit society. Alongside professional support for our members, we engage with policymakers and the public to increase awareness and understanding of the value that physics holds for all of us. Our subsidiary company, IOP Publishing, is a world leader in scientific communications, publishing journals, eBooks, magazines and websites globally.

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<sup>18</sup> [http://www.iop.org/policy/diversity/initiatives/membership/page\\_54903.html](http://www.iop.org/policy/diversity/initiatives/membership/page_54903.html)