IOP Institute of Physics

Institute of Physics submission to the Department for Education's review of post-18 education and funding

4 May 2018

The Institute of physics welcomes the opportunity to submit to this important review. We share the aims of the review – to ensure that appropriately funded higher and further education sectors are open to all to study to the limits of their ambition and ability – and are keen to support this work.

Main points:

- **Physics offers huge benefits to individuals and to society – opening doors, broadening horizons and driving innovation. It provides powerful and beautiful explanations about the workings of the world – explanations that have value and are applicable in a wide range of industries and research communities. Furthermore, it develops ways of thinking and reasoning that are rewarding and highly valued by employers in many sectors, from accounting to zoology to engineering, via law and medicine.**

- **These kinds of knowledge and skills will be essential to the achievement of the aims of the government's Industrial Strategy and the fulfilment of the Prime Minister's aim of "delivering jobs and economic growth to every community and corner of the country".[1]**

- **However, employers have for many years reported a significant mismatch between the demand and supply of skilled workers; the UK does not have the skilled people it needs, including those trained in physics.**

- **This review presents an opportunity to widen existing routes through post-18 education, and to increase the number and diversity of people who are trained in physics (at all levels) and who enter the workforce.**

- **To realise these benefits there must be greater visibility of existing routes through higher education (HE) and further education (FE) for both students and employers. For example, careers advice in schools is an important part of the post-18 education system and the government's Careers Strategy should be implemented in full.**

- **There is a significant opportunity to increase the number and level of science apprenticeships, and to widen access to apprenticeships, to the benefit of both students and employers. To do so will require a focussed programme to stimulate both supply of and demand for science apprenticeships.**

- **There is an opportunity to expand physics provision, diversity and uptake in HE through additional public support for the teaching of high-cost laboratory subjects.**

[1] Davos 2017: *Prime Minister's speech to the World Economic Forum* https://www.gov.uk/government/speeches/davos-2017-prime-ministers-speech-to-the-world-economic-forum

- **Any proposed changes to HE funding must be carefully modelled to avoid unintended consequences for provision of or access to subjects such as physics which are recognised as nationally important.**

The value of physics trained workers

Education and training in physics develops ways of thinking and reasoning that are rewarding and highly valued by employers.[2] HESA's destinations of leavers of higher education (DLHE) survey suggests that business, IT and engineering roles are the main employment destinations at six months after graduation[3] and IOP surveys have found physics graduates are employed in all sectors of the UK economy.[4,5] The subject is associated with a significant 'graduate premium'[6] providing benefit both to those studying the subject and also to the UK economy.[7]

The single biggest first destination for physics graduates in the DLHE data is "education", with one in three going in to study for postgraduate masters or PhDs.[8] A large proportion of these are in physics departments, but there are also significant numbers of physics graduates who go on to study for advanced degrees in engineering, medical physics and other STEM fields. These graduates form the basis of a part of the UK's research workforce. While the competitive academic career structure will mean that relatively few will ultimately become senior academic researchers or university professors, they will likely instead form part of the private sector research workforce, taking with them the skills that they have acquired.[9]

However the UK is currently producing too few physics graduates. The IOP's own employer engagement has found significant unmet demand for physics graduates. According to a CBI survey, nearly four in ten businesses are struggling to recruit workers with the advanced, technical STEM skills they need.[10] The Social Market Foundation recently calculated that despite recent increases, there remains an annual shortfall in domestic supply of around 40,000 STEM graduates in the UK. They suggest that, to address this, a 50% increase in the current number of STEM graduates in the UK is needed.[11] There is also evidence of a significant undersupply of technicians in UK industry.[12] The Gatsby Foundation estimates

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[2] Institute of Physics – *Your future with physics: Career directions* http://www.iop.org/careers/undergrad--postgrad/your-future/page_64487.html

[3] HESA DLHE survey

[4] Institute of Physics – *The career paths of physics graduates* (2012) https://www.iop.org/publications/iop/2012/file_55924.pdf

[5] *Wakeham Review of STEM Degree Provision and Graduate Employability* (2016) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518582/ind-16-6-wakeham-review-stem-graduate-employability.pdf

[6] BIS research paper 45: *the returns to higher education qualifications* (2011) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/32419/11-973-returns-to-higher-education-qualifications.pdf

[7] Historical data on the value of physics degrees to HMRC can be seen here : *The economic benefits of higher education qualifications* (2005) https://www.iop.org/publications/iop/archive/file_52061.pdf

[8] HESA DLHE survey

[9] The Royal Society – *The Scientific Century : securing our future prosperity* (2010) https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2010/4294970126.pdf

[10] Business Matters - *Business fear skills shortage could hold back growth* (2013): http://www.bmmagazine.co.uk/news/business-fear-skills-shortage-could-hold-back-growth/

[11] Social Market Foundation – *In the Balance: The STEM human capital crunch* (2013): www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf

[12] Engineering UK - *The state of engineering* (2015): http://www.engineeringuk.com/EngineeringUK2015/EngUK_Report_2015_Interactive.pdf

that the UK will need 700,000 more technicians over the next decade to meet demand from employers.[13] This review presents an opportunity to widen the routes to access the post-18 education system to allow companies to better access the scientific and technical skills that they need, including those of physicists.

Student choice

The ability of students to access the post-18 education system is often decided well before the student reaches the age of 18. Despite the clear demand from UK employers for STEM-qualified workers, large numbers of school students drop STEM subjects at the first opportunity, essentially preventing them from pursuing STEM qualifications post-18. Within physics this effect is more prevalent in some demographics than others, particularly in girls, students from lower socio-economic backgrounds, and students from certain ethnic minority backgrounds.[14] In many cases, the problem is an intersectional one, with individuals being members of more than one discrete and negatively affected group. To achieve the aim of a post-18 system of education that is open to all, and provides the skills the UK needs, these issues must first be tackled in the pre-18 system.

There is evidence that the most important aspect of engaging students with physics at school is a teacher with good subject knowledge and an ability to communicate this knowledge effectively.[15] Such 'specialist teachers' enhance the student experience and promote progression through the education system, ensuring that all students have the opportunity to reach their potential in physics. Currently we estimate that the school system in England lacks around 3000[16] specialist physics teachers – there are not enough new teachers being trained in physics to make up this shortfall quickly and to replace those who are retiring or leaving the profession. This shortage has long been recognised within government[17] and the DfE, alongside professional bodies such as the IOP,[18] has made some progress over the last decade in improving the situation.[19] The DfE must retain its strong focus on ensuring that every pupil is taught by a specialist in the subject throughout their time in school.

The engagement with the subject facilitated by specialist teachers must be complemented by effective and appropriate careers advice that allows school students to make informed choices about their futures. The government's Careers Strategy, launched at the end of 2017, identifies many of the current limitations of careers advice in schools and seeks to address them.[20] The strategy has an explicit focus on STEM subjects, non-degree pathways, and on the different barriers experienced by different school students from different

[13] Gatsby – *Stem Skills in the Workforce* http://www.gatsby.org.uk/education/focus-areas/stem-skills-in-the-workforce
[14] ASPIRES – *Young people's science and career aspirations, age 10 –14* (2013) https://www.kcl.ac.uk/sspp/departments/education/research/aspires/ASPIRES-final-report-December-2013.pdf
[15] Alan Smithers and Pamela Robinson – *Physics in Schools IV: Supply and Retention of Teachers* (2008): http://www.gatsby.org.uk/uploads/education/reports/pdf/16-physics-in-schools-supply-and-retention-of-teachers-june-2008.pdf
[16] Based on IOP modelling
[17] Government press release -- *New plans to attract and train maths and physics teachers* (2015) https://www.gov.uk/government/news/new-plans-to-attract-and-train-maths-and-physics-teachers
[18] IOP Teacher Training Scholarships http://www.iop.org/education/teach/itts/page_52632.html
[19] http://www.gatsby.org.uk/education/programmes/teacher-recruitment-retention-and-development
[20] DfE - *Careers strategy: making the most of everyone's skills and talents* (2017) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664319/Careers_strategy.pdf

demographics and backgrounds.[21] Careers advice in schools is an important part of the post-18 education system and the strategy should be implemented in full.

The UK's post-18 education system cannot succeed without a similarly effective pre-18 education system. This review should ensure that its work takes account of current and proposed schools policies in England.

Physics provision

Post-18 provision of physics education is largely delivered through universities, FE colleges, and through apprenticeships.

- **Technical and Vocational Pathways**

Within FE there is a lack of visibility of physics to prospective students and also employers. While in HE there are clear routes to and career paths from physics qualifications, this is not currently the case for physics related qualifications in FE or for apprenticeships, where physics skills, knowledge and ways of thinking are incorporated into a wide range of qualifications and industrial sectors. This lack of visibility may be a factor in employers reporting significant demand for high level technical skills that the current systems are not able to meet. The development of the core content for T levels may go some way to address this lack of clarity and provide a clear career path for students and a framework through which employers can engage.

Science apprenticeships have the potential to provide a stronger, more attractive and more visible career path into scientific technical roles. Over the past five years starts in STEM apprenticeships[22] in England grew from 95,000 in 2012/13 to 112,000 in 2016/17.[23] While these top-level numbers are encouraging, this growth was mainly driven by increases in apprenticeships in 'engineering and manufacturing technologies' which accounted for 67% of all STEM apprenticeships in 2016/17, and 'construction, planning and the built environment' which accounted for 19%. The majority of apprenticeships are also at the lower skills levels: of the total STEM apprenticeship starts in 2016/17, 55% were at Level 2, 41% at Level 3 and 3% at Level 4 and above. Less than 1% of STEM apprenticeship starts (290) in 2016/17 were in science and mathematics. The low numbers of science apprenticeships within the otherwise high number of STEM apprenticeships may be a feature of the reported mismatch between supply and demand of STEM skills in the UK.

There are significant challenges in widening access to STEM apprenticeships. Women made up only around 8% of STEM apprenticeship starts in 2016/17, despite representing more than 50% of all apprenticeship starts overall,[23] something that has been acknowledged by the government.[24] There is a significant opportunity to expand the number, access and level of science apprenticeships to the benefit of both students and employers. To do so will require a focussed programme to stimulate both supply and demand. Such work could mirror

[21] The Royal Society – *Exploring the relationship between socioeconomic status and participation and attainment in science education* (2008) https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2008/4294969756.pdf

[22] Classified as: Construction, Planning and the Built Environment; Engineering and Manufacturing Technologies; Information and Communication Technology; or Science and Mathematics.

[23] National Audit Office – *Delivering STEM skills for the economy* (2018) https://www.nao.org.uk/report/delivering-stem-science-technology-engineering-and-mathematics-skills-for-the-economy/

[24] Department for Education – *Apprenticeship reform programme: benefits realisation strategy* (2017) https://www.gov.uk/government/publications/apprenticeship-reform-programme-benefits-realisation-strategy

the successful HE STEM programme[25] funded by HEFCE, which had a similar supply and demand model.

- **Higher education**

Over recent years the number of people studying physics at undergraduate level in the UK has increased significantly. There were 3675 graduates from undergraduate physics courses in UK universities in the 2015/16 academic year (compared with 3190 in 2004/5).[26] Alongside this, and following a period in which university physics departments were closing, several new physics departments have opened in the last decade. These new departments have added overall capacity and geographic spread to the UK physics provision, and also added diversity of provision, with new degrees coming online focussing on eg applied physics[27] complementing the existing research-led and theoretical physics undergraduate courses. However, even with these increases, there are still only around 50 university physics departments in the UK,[28] largely in pre-1992 universities (and largely in universities that have been reported to have most "unequal" student bodies[29]).

While there are no longer external caps on the number of students that universities can recruit, there are limitations of space to accommodate and teach students – with additional limitations in subjects such as physics which require laboratory space for undergraduate teaching. There are also financial limits, for similar reasons. It is acknowledged that UK university physics at undergraduate level is taught at a financial "loss" by universities,[30] with student fees not sufficient to match the cost of teaching the subject effectively. Physics courses have specialist, high cost requirements – laboratory space, research-grade equipment – to support effective teaching and enable students to develop the skills and competencies needed to become practising scientists. In a recent IOP survey, the average teaching cost per student in 2012/13 was £9,839 for physics.[31] This is significantly more than the average paid by undergraduate students after waivers and bursaries. HEFCE estimates, based on TRAC data, that the annual cost of a physics degree per full-time student is £10,504. In England, the shortfall in teaching income per FTE student has been partially mitigated by separate additional public funding, available since 2007/08, for high-cost subjects such as chemistry and physics.[32] However, the value of this additional funding has fallen in cash terms by around £370 per FTE taught student in physics since it was introduced. As such, undergraduate provision in physics is only possible with additional support from central university budgets.

The relatively small number of university departments offering physics degrees, combined with the relatively high cost of teaching the subject, means that any changes to the way that

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[25] National HE STEM Programme – *Final Report* (2013) https://www.birmingham.ac.uk/Documents/college-eps/college/stem/national-he-stem-programme-final-report.pdf

[26] HESA data

[27] For example http://www.port.ac.uk/courses/mathematics-and-physics/bsc-hons-physics/

[28] IOP Register of Accredited Courses http://www.iop.org/education/higher_education/accreditation/file_69855.pdf

[29] HEPI – *Benchmarking widening participation: how should we measure and report progress?* (2018) http://www.hepi.ac.uk/wp-content/uploads/2018/04/HEPI-Policy-Note-6-Benchmarking-widening-participation-FINAL.pdf

[30] House of Commons Library – *Higher education tuition fees in England* (2018) http://researchbriefings.files.parliament.uk/documents/CBP-8151/CBP-8151.pdf

[31] IOP and RSC - *The Finances of Chemistry and Physics Departments in UK Universities: Third Review* (2015) http://www.iop.org/publications/iop/2015/file_66515.pdf

[32] HEFCE – *Funding for higher education in England for 2017-18 HEFCE grant letter from the Department for Education* (2017) http://www.hefce.ac.uk/news/newsarchive/2017/Name,112915,en.html

higher education is funded may have significant impacts on the provision of physics degrees in the UK and so on the supply of skilled workers the nation needs. Any proposed changes to HE funding must be carefully modelled to avoid unintended consequences for provision of or access to subjects such as physics which are recognised as nationally important. We are not in favour of any system which relates the level of fees paid by students to undertake a degree to the perceived value of the degree or to the cost of teaching the degree which will likely have adverse effects on both take up and provision of physics degrees.

The sensitivity of the physics HE system may also present an opportunity to expand provision and access to physics through, for example, bringing the additional public funding of physics teaching in HE up to a level where it is economic for more universities to offer physics degrees. Such an increase in provision, if not confounded by other changes eg raised student fees, could have the effect of further increasing geographical diversity and diversity of provision, and so overall numbers of students taking physics degrees, so strengthening the UK's skills base.

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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