IOP Institute of Physics

Institute of Physics response to the Department for Education Green Paper: Schools that work for everyone

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The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all. We have a worldwide membership of more than 50,000, from enthusiastic amateurs 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're here 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 world leader in scientific communications, publishing journals, ebooks, magazines and websites globally.

We welcome the opportunity to respond to the Green Paper, 'Schools that work for everyone'. We recognise the importance of raising attainment in schools, particularly in science, technology, engineering and mathematics (STEM) subjects, and increasing the proportion of students from diverse demographics and backgrounds progressing in STEM and in education generally. The UK has a STEM skills gap[1]. This submission focuses on initiatives that will increase the proportion of students developing STEM skills. Students benefit hugely from studying subjects such as physics, which is one of the most frequently cited facilitating subjects for both STEM and non-STEM degree courses.[2]

The best way to resolve the STEM skills gap will be to widen participation in STEM so that underrepresented groups – such as students from minority ethnic backgrounds or female students in subjects like physics– increase their participation. Currently, for a number of reasons, individuals from a range of backgrounds do not feel encouraged, supported or empowered to enter STEM subjects.

Efforts to address this gap and to increase the numbers of students from underrepresented and disadvantaged backgrounds going in to STEM subjects must be based on evidence. As a first principle, it would be best to support, expand, and further develop existing measures that have been shown to be effective in furthering each of these aims. If evidence is lacking, then further work should be performed to strengthen the evidence base for existing measures. If new programmes and initiatives are to be taken forward, then these should rely on the best existing evidence possible - whether from the UK or abroad - and as far as is possible, be piloted, monitored, and evaluated, before being expanded.[3]

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[1] Social Market Foundation - *The STEM Capital Crunch* (2010): http://www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf

[2] Russell Group - *Subject choices at school of college*: http://russellgroup.ac.uk/for-students/school-and-college-in-the-uk/subject-choices-at-school-and-college/

[3] We recommend the submission from the Royal Society for a review of the data related to attainment in the sciences and selective education.

This submission focuses specifically on efforts that higher education institutions can make to improve attainment in schools and widen participation amongst the most disadvantaged and underrepresented groups.

In particular:

- The recruitment and retention of subject-specialist teachers has been shown to be extremely important in increasing attainment and progression in schools, and universities may be able to play a role to aid and enhance existing programmes.
- Universities' efforts to support attainment and progression of disadvantaged and underrepresented groups in schools, particularly in STEM, may be best served by encouraging greater efforts at building partnerships and collaborations with existing schools.
- Universities should only explore establishing new schools if they have strong reasons to do so; rushing forward with a plan for all universities to establish schools could create perverse incentives which would not be good for schools education.
- Any efforts to increase the number of university-operated schools should begin with a substantial pilot study in order to gather data on which, if any, methods are most effective, particularly at increasing widening participation.

Physics and access

Almost all STEM subjects face challenges relating to access. These challenges may be in the form of barriers, for example resource based barriers such as a lack of specialists to teach the subject or social barriers such as negative gender-based perceptions of certain subjects. The challenges are heightened within physics, where representation of girls and women and students from ethnic minority backgrounds is lower than in most other STEM subjects. For example, just 22% of students completing an A-level in physics in 2016 were female and female students comprise just 21% of students in UK physics departments. Entry requirements for physics means that the population of possible female physics undergraduate students is largely defined by the population of female students taking A-level physics, as this is almost always a pre-requisite to pursuing a physics degree. As such, if universities want to widen participation, then there are good reasons to address issues of access and participation in STEM in schools.

There are a number of barriers to students studying physics at A-level, including prior attainment at GCSE. There is evidence to suggest that many schools expect a higher threshold for attainment in physics to progress to physics A-level than for other subjects, including most other STEM subjects. For example, almost all students taking A-level physics received a B or above at GCSE.[4] This not only serves to limit the pool of potential students, but may also discourage students from taking a subject they see as 'too difficult'. Streaming of students also means that students are already separated into classes based on prior attainment before they choose their A-levels, meaning that a number of students are already ruled out from taking physics. A proven way to improve attainment and progression in STEM subjects is for classes to be taught by specialist teachers with the ability to confidently understand and communicate their knowledge of their subject to students.[5] Not all students

[4] Charles Tracy – *The effects of grading on choice:* http://www.iopblog.org/the-effects-of-grading-on-choice/

[5] Department for Education - *The Case for Change* (2010): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/180852/DFE-00564-

have access to specialist teachers, and so either miss the chance to study physics or are taught by someone with little or no grounding in the subject. The IOP runs a number of programmes, including the DfE-supported Stimulating Physics Network (SPN), that work to provide teachers with this improved subject knowledge to give them more confidence to teach physics and enable and empower their students.

Outside of schools, families have a big role to play in encouraging students to take STEM subjects. Many students are strongly influenced by their parents' recommendations and choices. Those families with low 'science capital' – without positive associations or experiences of or understanding of science – are much less likely to see their children studying a STEM subject.[6] Universities may also have a role to play here to increase families' engagement and positive understanding of science.

Q: How can the academic expertise of universities be brought to bear on our schools system, to improve school-level attainment and in doing so widen access?

The green paper states the Government "believe all universities could and should play a direct role in raising attainment in schools to widen access, and for this to be made a condition of their fair access requirements." Whether they establish a new school or sponsor an academy, universities should only explore such involvement in the provision of schools if they have strong reasons to do so. For example, they may have very particular expertise or links with a local area and they should be able to demonstrate that they have the right resources to build a sustainable model – even if the government will be underwriting capital and revenue costs. In addition, the green paper expresses a desire to see universities "begin to sponsor schools as soon as possible". We would caution against such haste.

While there are some good examples, particularly of specialisation, such as King's College London Mathematics School, success is not universal. Universities may be very experienced at teaching undergraduate students, but the same skills and expertise used to teach undergraduates may be inappropriate for teaching school students. This is particularly likely to be the case with those students facing the greatest barriers to learning, who are less numerous within higher education.

Allowing universities to offer higher fees as an incentive to establish schools risks creating perverse incentives for universities; encouraging those lacking the right resources or expertise to take risks, which would be unwelcome within the schools system. Additionally, if there is a move in future towards differential fees between courses within universities, for example as a result of the Teaching Excellence Framework (something which would itself be unwelcome), then it would be hard to see how this could continue to work; the incentives no longer existing across the board for a university.

If any programme were to be carried forward, it should begin with a set of pilots to allow the creation of an evidence base and establish best practice. This would require trialling different methods in different parts of the country to gather enough data to see how effective universities are at running schools, and what may or may not work best – whether in terms of the school administration, use of university expertise, or specialisation. As an example,

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2010.pdf Original references for this point: (Smithers and Robinson, 2005; Goldhaber and Brewer, 1997 and 2000; and Wilson et al, 2001.)

[6] King's College London – *ASPIRES: Young people's science and career aspirations, age 10 –14* (2013): http://www.kcl.ac.uk/sspp/departments/education/research/aspires/aspires-final-report-december-2013.pdf

HEFCE's recent approach to learning gain has been sensible – launching a wide range of pilots over a number of years across different consortia of universities to assess which methods may, or may not, be best at understanding learning gain.[7]

Q: Are there other ways in which universities could be asked to contribute to raising school-level attainment?

Universities are not evenly distributed geographically, and this distribution is even more uneven in departments, such as physics, which require greater resource and input within schools. As such, universities would be best placed to explore using their resources through partnerships or collaborations, particularly to address specific challenges, or to work with existing programmes which have a record of success.

A major challenge to improved attainment in schools is a lack of effective and specialist teachers, or teachers with a strong background in their subject. The Department for Education recognises this and in 2010 stated that "research [in the UK] strongly suggests that subject knowledge as well as overall attainment [of teachers] is a key determinant of success, especially in the sciences and mathematics".[8] This is particularly problematic within physics, where there is a shortage of around 4500 teachers.[9] Although there have been some improvements in the number of physics teachers recruited in recent years, with the Government getting close to reaching its target in 2012[10], this has slipped back since, and 870 physics teachers were recruited in 2016. Since 2013 universities have played less of a role in training new teachers, with more focus placed on school-based routes to initial teacher education. Universities have a strong track record in training teachers and although places are not capped for training physics teachers as they are in other subjects, the NAO has suggested that the complexity of the system could be acting as a barrier to effective recruitment.[11]

Programmes of support could also involve existing schemes such as physics with qualified teacher status (QTS) degrees[12] and the Researchers in Schools project which "offers a bespoke route into teaching exclusively for PhD graduates" and also provides participants with a route towards QTS.[13]

Universities could also play a role in supporting and expanding programmes which have proved successful in raising attainment and progression. The Institute of Physics operates the Stimulating Physics Network which is already supported by the Department for Education. SPN provides bespoke support for more than 420 schools to improve physics teaching and has been found to increase progression and attainment of students compared to those schools not operating the programme, with greater than average results for girls.

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[7] HEFCE – *Learning Gain*: http://www.hefce.ac.uk/lt/lg/work/

[8] Department for Education - *The importance of teaching: the schools white paper 2010*: https://www.gov.uk/government/publications/the-importance-of-teaching-the-schools-white-paper-2010

[9] Institute of Physics - *A response to an Education Select Committee consultation on the Supply of Teachers* (2015): https://www.iop.org/policy/consultations/file_66631.pdf

[10] Gatsby Foundation - *The Shortage of Physics Teachers*: http://www.gatsby.org.uk/uploads/education/reports/pdf/the-shortage-of-physic-teachers-an-infographic1.pdf

[11] National Audit Office – *Training New Teachers* (2016): https://www.nao.org.uk/wp-content/uploads/2016/02/Training-new-teachers.pdf

[12] Edge Hill University - *BSc (Hons) Secondary Science (Physics) Education with QTS*: https://www.edgehill.ac.uk/courses/secondary-science-physics-education-with-qts/

[13] Researchers in Schools: http://www.researchersinschools.org/

Localised support and buy-in from universities into such a programme could help it expand and reach more students.

Where educational and pedagogical research is being pursued at universities there may be greater opportunities to encourage them to collaborate with schools. Links between pedagogical subject researchers in universities and teachers in schools are not always effective, and a programme to build greater links between these researchers and local schools to improve and to address specific challenges would be welcome.

Universities could also be encouraged to play a more specific role within their local area to build engagement and understanding of science within families and the community. Universities often have a strong basis within a local community or area, and are likely to have significant networks across a range of businesses, public bodies and other organisations. As relatively centralised local actors, and significant employers, they are well placed to support efforts to build science capital within families in their vicinity. This could be through outreach and engagement activities with parents in the local community, summer schools, placements and visits for school students within STEM departments, and engaging directly with their own staff.

Q: What is the best way to ensure that all universities sponsor schools as a condition of higher fees?

Trying to ensure that all universities sponsor schools would be unwelcome. Universities have a wide range of objectives and missions and the differences between universities can be similarly large. Many universities also lack the resources, experience, funding and expertise to effectively open a school. Providing incentives to universities to open schools could also encourage universities to take risks in entering schools education. Such behaviour could be deleterious to students' education.

Q: Should we encourage universities to take specific factors into account when deciding how and where to support school attainment?

Yes. The measures listed in the green paper are a much more sensible route for universities to support schools (instead of, rather than in addition to a blanket incentive to establish schools themselves). Universities may also be able to help schools in the short term with, for example, regional shortages of physics teachers. Programmes could be put together to train up university lecturers to teach STEM subjects at school level, particularly those in physics and engineering, to provide some relief and capacity to schools where they need it.

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