National Audit Office

Report
by the Comptroller
and Auditor General

Department for Business, Energy & Industrial Strategy
Department for Education

Delivering STEM (science, technology, engineering and mathematics) skills for the economy

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Department for Business, Energy & Industrial Strategy
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Delivering STEM (science, technology, engineering and mathematics) skills for the economy

Report by the Comptroller and Auditor General

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This study examines whether the departments' approach to boosting participation in the science, technology, engineering and mathematics (STEM) education pipeline at all levels is likely to address the STEM skills challenge in a way that achieves value for money.

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Contents

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Key facts

£990m

spent on, or committed to, key STEM-specific interventions between 2007 and autumn 2017

442,000

undergraduate enrolments in STEM subjects in 2015/16

24%

of graduates in STEM subjects known to be working in a STEM occupation six months later

700,000	additional STEM technicians the Gatsby Charitable Foundation estimates will be needed to meet employer demand in the decade to 2024
112,000	STEM apprenticeship starts in 2016/17
8%	of STEM apprenticeships started by women in 2016/17, despite women accounting for over 50% of all apprenticeship starts
£80 million	government investment in national colleges, including in high-speed rail; nuclear; onshore oil and gas; and digital
2.6%	rise in the number of STEM A level examination entries in 2016/17 compared with the previous year
30.9%	fall in the number of enrolments in part-time undergraduate STEM degrees between 2011/12 and 2015/16
£200 million	government capital investment in higher education STEM provision in 2015/16

Summary

Background

1 STEM stands for science, technology, engineering and mathematics. In education, it means the study of these subjects, either exclusively or in combination. In employment, STEM refers to a job requiring the application of science, technology, engineering and mathematics skills or a qualification in a relevant subject, or located in a particular industry or sector. There is no universally accepted definition in either setting.

2 Since the early 2000s there has been growing concern, including from government, about how to achieve higher productivity and economic growth in an era of rapid technological change. Over time, this has generated the widely held belief that one of the UK's key economic problems is a shortage of STEM skills in the workforce. Most recently, the November 2017 policy paper, *Industrial Strategy: Building a Britain fit for the future*, stated that "…we need to tackle particular shortages of STEM skills. These skills are important for a range of industries from manufacturing to the arts". Some employers in STEM sectors have also suggested that exit from the European Union (EU) may affect the availability of people with the requisite STEM skills, but the precise impact is hard to predict.

3 People can develop formal STEM skills and knowledge in different ways, either in an educational setting or in the workplace. This can be seen as a 'pipeline', through which learners move in order to acquire more advanced abilities. The key routes for developing STEM knowledge and skills are: schools and sixth-form colleges; further education colleges; apprenticeships, which mix work with formal off-the-job training; and higher education institutions.

Government intervention

4 Responsibility for developing STEM skills involves a number of government departments, and is embedded across a number of non-STEM specific policy areas. The Department for Education (DfE) is responsible for the majority of STEM skills interventions. The Department for Business, Energy & Industrial Strategy (BEIS) has a cross-cutting role, including work on doctoral training and STEM inspiration, and setting the national framework for science and technology. Other departments, including the Department for Digital, Culture, Media & Sport and the Ministry of Defence, run individual STEM-related programmes and initiatives.

5 Aside from the core teaching of STEM subjects, some of the most significant initiatives in terms of spending are:

- providing higher education institutions with additional money to support their teaching of very high-cost STEM subjects;
- allocating capital funds to enhance higher education STEM teaching facilities; and
- running university technical colleges, which were set up to offer 14- to 19-year-olds a combination of technical, practical and academic learning.

Scope and approach

6 This report focuses on government's overall approach to enhancing STEM skills, and how each section of the STEM skills pipeline is performing, looking in particular at the development of STEM skills in those aged over 16. It covers the situation in England, in keeping with the responsibilities of the key government departments involved. Its main focus is on DfE and BEIS, but it also references a number of other departments that have responsibility. The report examines three main areas:

- government's understanding of the need for enhanced STEM skills in the workforce (Part 2);
- what the performance of the education pipeline shows about the effectiveness of past initiatives in delivering STEM skills (Part 3); and
- the opportunities and risks associated with the latest initiatives to enhance the development of STEM skills (Part 4).

Key findings

Government's understanding of the need for enhanced STEM skills in the workforce

7 **Government does not currently gather robust intelligence on the STEM skills issues it has already started to address.** The UK Commission for Employment and Skills (UKCES), the public body previously responsible for collecting and analysing labour market intelligence, and forecasting skills needs, closed in March 2017. Its research function was transferred to DfE in late 2016. DfE has since announced that it will develop Skills Advisory Panels to oversee skills needs at a local level, but it is too early to tell whether these will produce robust assessments of current and future skills needs. Currently, the case for intervening on STEM skills, as put forward in the November 2017 industrial strategy policy paper, is based on skills gap estimates from employer representative groups, and historic UKCES analysis (paragraphs 2.2 to 2.5 and 2.22).

8 **Current estimates of the STEM skills problem vary widely, and typically focus only on individual sections of the workforce.** Estimates of skills needs generated by sectoral and employer groups tend to be narrow in focus or too generalised to provide a sufficiently detailed understanding of overall STEM skills needs. We have produced our own analysis, which indicates that current and predicted shortages vary by skill level and also demonstrates the difficulty of producing reliable estimates using available data and methodologies. Modelling future needs is especially problematic due to the difficulty of predicting the effects of technological changes and future events (paragraphs 2.13, 2.14, 2.16, and Figure 3).

9 **Government does not have a stable and consistent set of definitions for STEM, in either an educational or a work context.** STEM is a complex and overlapping group of subject areas that can be defined in a number of different ways, depending on the criteria used. In a work context, Standard Industrial Classification (SIC) or Standard Occupational Classification (SOC) codes can be used to arrive at very different results when analysing 'STEM jobs' and identifying the nature and extent of any STEM skills shortage. Without a more stable, consistent set of definitions, government will be less able to understand the problem in a meaningful way, target initiatives effectively, or measure their overall success (paragraphs 2.10 to 2.12).

10 **Existing evidence indicates that there is a STEM skills mismatch rather than a simple shortage.** A mismatch can include many types of misalignment between the skills needed and those available in the labour pool. Our research indicates that there are particular shortages of STEM skills at technician level, but an oversupply in other areas, such as biological science graduates, who are then often underemployed in an economy in which they are not in high demand. There is also evidence to suggest that, at graduate level and above, the problem is sometimes one of quality rather than quantity, with people not having all of the employability or practical skills they need to enter the workforce (paragraphs 2.14, 2.15 and 2.17 to 2.21).

11 **Government is starting to improve coordination on STEM and address past incoherence.** Departments have begun taking steps to set out clearly what they are seeking to achieve and what success will look like. A single lead for STEM has been appointed within DfE and, at the end of our fieldwork in September 2017, DfE was developing more specific objectives. Relevant departments were also in the process of establishing new STEM governance boards to foster a joined-up approach. These measures should help to address historical issues of incoherence, but until they are fully implemented, there is a risk that the overall approach remains incohesive, that various strategies that support STEM will not be aligned, and that emerging issues will not be dealt with in a timely way (paragraphs 2.6 to 2.9).

12 **The impact of exit from the EU is difficult to predict, with some major science and engineering bodies believing that exit from the EU could reduce the availability of STEM skills in the short term.** BEIS and DfE are involved in cross-government work to assess the wider impacts of exiting the EU. This will be informed by the work of the independent Migration Advisory Committee (paragraphs 2.23 to 2.25).

The performance of the education pipeline in delivering STEM skills

13 **Some STEM initiatives have been effective but overall coordination has been lacking.** Some initiatives have had a positive impact, and those targeted at A levels saw entries grow by 3% between 2011/12 and 2016/17. However, overall these initiatives are not sufficiently coordinated at programme level to take full advantage of synergies, or to mitigate the risk of duplication. This is exacerbated by the absence of a dedicated evidence-gathering function, and the fact that robust evaluations have not been carried out on all initiatives so far to identify what works (paragraphs 2.2, 2.6, 2.8, 3.3 to 3.5, 4.8 to 4.10 and 4.12, and Figures 4, 5 and 10).

14 **Females are underrepresented in most STEM subject areas at every stage of the STEM skills pipeline.** In 2016/17, female students accounted for only 42% of all STEM A level exam entries, making up just 9.4% of examination entries in computing, 21.2% in physics, and 39% in mathematics. Females made up only around 8% of STEM apprenticeship starts in 2016/17, despite representing more than 50% of all apprenticeship starts overall, and around 38% of enrolments on undergraduate STEM courses, again despite accounting for more than 50% of all enrolments. There is also evidence of gaps on the basis of other characteristics, such as ethnicity and socio-economic background, but the information and analysis currently available on these characteristics is less comprehensive (paragraphs 3.6, 3.8, 3.19 and 3.23, and Figure 6).

15 **The number of people participating in STEM-related vocational courses has risen in some areas but not others.** Starts in STEM apprenticeships grew from 95,000 in 2012/13 to 112,000 in 2016/17. This was mainly driven by growth in apprenticeships covering: engineering and manufacturing technologies; and construction, planning and the built environment. The number of non-apprenticeship STEM further education learning aims being studied, however, remained at around 110,000 between 2011/12 and 2015/16 (paragraphs 3.8, 3.9 and 3.12, and Figure 7).

16 **However, enrolments in undergraduate STEM courses have fallen slightly since 2011/12, and in subjects where there has been growth this appears to reinforce reported skills mismatches.** Between 2011/12 and 2015/16, enrolments in full-time STEM degrees rose by 6.9% against an overall rise in all subjects of 1.1%. Enrolments in biological sciences saw the strongest growth, while enrolments in engineering and technology and physical sciences have grown less strongly. However, take-up of part-time undergraduate STEM courses fell by over 30% in the same period, from almost 98,000 to around 68,000, as part of a collapse in part-time degree enrolments that saw them fall by 47% overall (paragraphs 3.17, 3.18 and 3.22, and Figure 8).

17 According to longitudinal research, of the 75,000 people who graduated with a STEM degree in 2016, only 24% were known to be working in a STEM occupation within six months. Some of the remainder, including the 15,000 (19.9%) whose destinations are unknown and the 13,000 (17.6%) going on to further study, may end up in STEM occupations. Improvements are currently being made to the quality of the graduate outcomes data, including delaying the data collection point to between 12 and 18 months after graduation. This should help DfE do more to understand why the proportion of STEM graduates entering STEM occupations is so low, and what can be done to improve the situation (paragraph 3.20).

The latest initiatives designed to enhance the development of STEM skills

18 There are several new initiatives in further education, which will need to establish their position in an already complex landscape. Technical levels (T levels) are designed to improve vocational education by standardising qualifications, aligning syllabuses with employer demand, and establishing 15 clear 'routes' into careers. The national colleges programme aims to develop high-level technical skills in sectors important to the UK economy, four of which focus on STEM skills: high-speed rail; nuclear; onshore oil and gas; and digital. The business case for each college is supported by detailed projections of supply and demand for skills, so they are well-targeted at areas of need within their specific sectors (paragraphs 2.15, 4.3 and 4.4, and Figures 10 and 11).

19 The November 2017 industrial strategy policy paper re-stated a proposal for institutes of technology, which will target skills gaps at levels 4 and upwards, particularly in STEM areas. As new institutions being introduced into an already crowded provider marketplace, there is a risk that they may face challenges in establishing their position (paragraph 4.5).

20 In the schools sector, better training and attempts to attract former teachers back to the workforce show some positive results. Early stage research indicates that the £67 million maths and physics teacher supply package, aimed at recruiting an additional 2,500 teachers and improving the skills of 15,000 non-specialist teachers in these subjects, is having a positive impact. However, a recent National Audit Office report also found that elements of the programme have been less successful, with the return to teaching pilot, for example, recruiting 428 returning teachers, just over half of its target of 810, of whom 330 completed the training provided (paragraph 4.8).

Conclusion on value for money

21 DfE and BEIS face a complex challenge to improve the quality of teaching and student take-up in key STEM subjects. Some of their initiatives are achieving positive results but there remains an urgent need for a shared vision of what they are trying to achieve and coordinated plans across government. The absence of a precise understanding of the STEM skills problem means the efforts of DfE and BEIS are not well prioritised and a better targeted approach is needed to demonstrate value for money.

Recommendations

22 DfE should:

a **Configure the labour market intelligence generated by Skills Advisory Panels and other mechanisms so that it enables effective decision-making.** Currently, the case for increasing the supply of STEM skills is based on different pieces of research that provide insufficient insight into the nature of the challenge.

b **Provide departments with clarity on the different STEM definitions used in different contexts, and reasons for these different definitions.** Without this clarity, meaningful comparisons of progress across different policy areas will always be challenging.

23 BEIS should:

c **Strengthen its work to evaluate and identify what is effective in its activities to promote participation in STEM education and skills development, and ensure this is shared with its delivery partners.** A range of different entities oversee or deliver activities to promote STEM. BEIS should continue to share good practice among them.

d **Working with other departments, use data on skills mismatches resulting from EU exit to establish the position across relevant sectors and determine whether key capabilities are at risk.** At present, there are clearly conflicting views about the likely impact on the availability of skilled workers and the flow of higher education students.

24 DfE and other key departments should:

e **Take steps to influence the skills marketplace in priority areas where insufficient development of STEM skills is taking place.** Departments are starting to take positive steps towards establishing better mechanisms to identify priority areas, but this intelligence will only be meaningful if the departments have the ability to influence the marketplace to develop the necessary skills.

f **Fully embed a more structured approach to STEM across government.** DfE has recently re-started a cross-government group to consider STEM issues involving all the key departments. This group needs long-term continuity to ensure the individual policies and strategies that support STEM are aligned and cohesive, and do not duplicate effort.