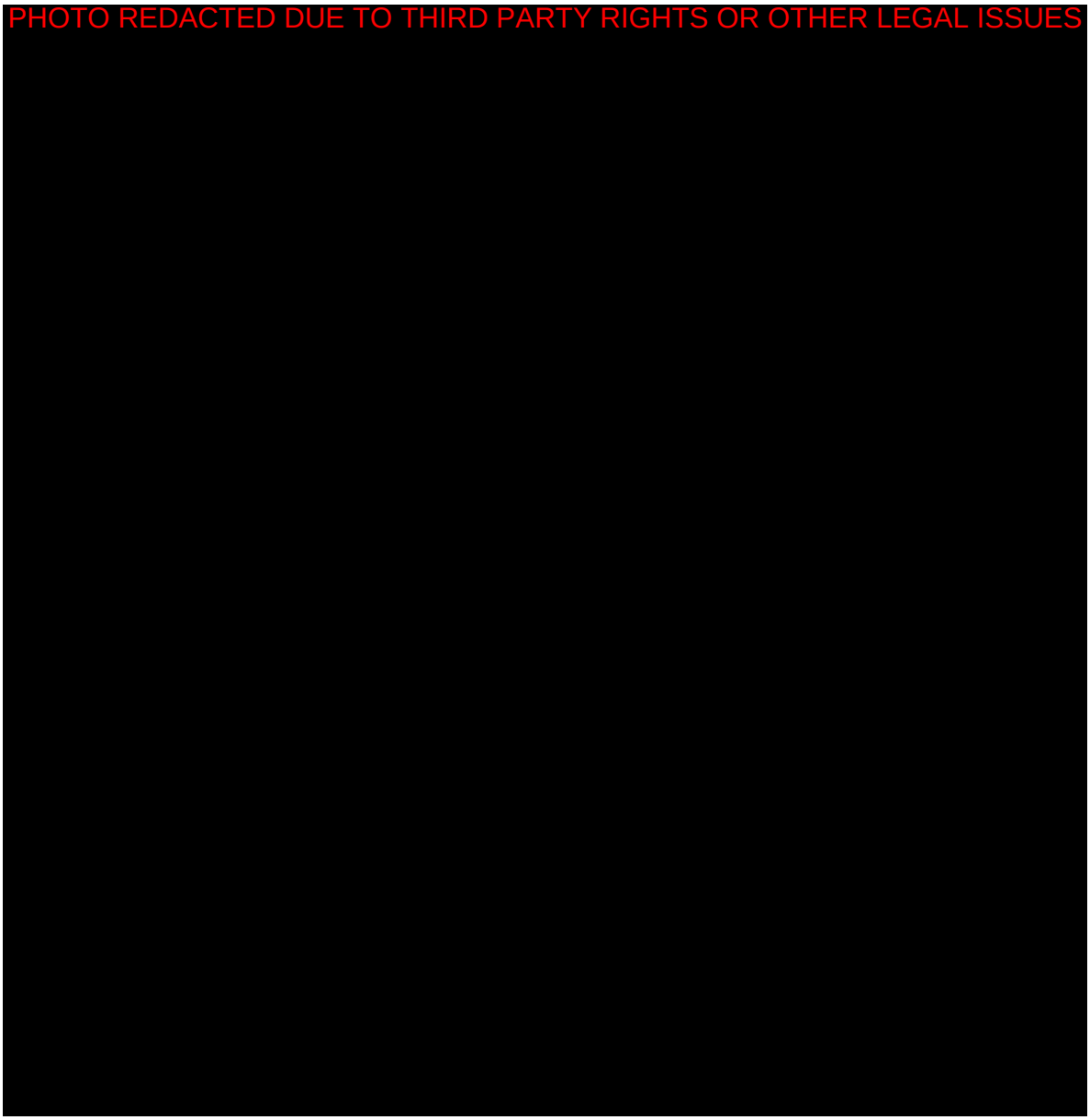
Wakeham Review of STEM Degree Provision and Graduate Employability



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1 Foreword by Sir William Wakeham

In the modern global competition for economic success one of the vital elements is the development of people who generate, exploit and organize the knowledge base connected with the disciplines that fall under the acronym of STEM (Science, Technology, Engineering and Mathematics). It is, therefore, not surprising that successive governments, in the UK and elsewhere, have given much prominence to ensuring that the flow of graduates from STEM degrees into economic activity is appropriate and fit for purpose. This review was charged primarily with identifying those disciplines within English Higher Education (HE) provision where graduate employment outcomes appear to be particularly poor, and where it can therefore be inferred that graduate skills and knowledge are not delivering what the associated economy and business community require. The vast range of HE disciplines encompassed within STEM, and the even larger industrial base that their graduates sustain and enhance, means that the review has had to be conducted at a high level. The fact that the industrial need for STEM graduates maps very imperfectly onto the HE disciplinary structure has added to the complexity of the task, but I have been keen that the review should be rigorous in its approach. Accordingly, we have sought to correlate various pieces of evidence to come to our conclusions around the academic areas where there should be the greatest concern rather than using just one source.

We have also been conscious of the fact that HE is not and should not be solely about short term economic benefit. Universities have a unique role to educate to a high level for the sake of the intellectual well-being of the country and the individual as well as enabling people to successfully take up employment. This is a real challenge in the modern world because it implies that universities need to equip their students with the skills that current industry needs at the same time as providing them with the means to re-invent and upskill themselves over a 50-year working lifetime in which change is endemic and accelerating. It is a fact that most STEM graduates enter the private sector of the economy and that, therefore, the voice of employers needs to be heard with respect to the attributes they seek in graduates. At the same time this must be balanced with a longer term vision for education. There is therefore a very clear need, that has often been expressed, that greater collaboration between business and HE is vital to ensuring appropriately educated and skilled graduates. The implied partnership endows each partner with responsibilities that should be explicitly accepted. The importance of this partnership is not a new revelation in this review, but the benefits that accrue when it works are made clear here. The accreditation of degree programmes under the auspices of professional, statutory and regulatory bodies is an important enabling feature of the current landscape that should be more effectively exploited throughout STEM as the review concludes.

I am grateful to all who contributed their thoughts and efforts to this review, particularly the Advisory Group who were both supportive and constructively critical.

2 Executive summary

2.1 To ensure that it can remain competitive in a diverse and fast-paced global economy, the UK needs to ensure that it has access to the people, skills and knowledge that it requires. High value, knowledge-intensive activities are increasingly at the heart of global and UK growth and productivity agendas and consequently there is a growing demand for people with high level and economically-valuable skills. Science, Technology, Engineering and Mathematics (STEM) skills are central to this and have an important role in developing and contributing to the technical and scientific innovation that will drive the next generation of high value products, services and the burgeoning information and data-driven economy. Ensuring that the UK has a readily available and high quality source of workers from STEM backgrounds, and in particular that UK businesses are able to gain access to these people, is therefore crucial.

2.2 An important part of the UK's long-term economic resilience needs, therefore, to be based on the development, provision and accessibility of the pipeline of highly-skilled STEM workers. This review was commissioned in response to concerns that the high level skills coming through the higher education (HE) system are, in some respects, failing to meet the need. In particular, evidence has previously suggested that some STEM degree disciplines suffer from relatively poor graduate employment outcomes and that employers have raised concerns around the quality and nature of the skills possessed by some graduates.

2.3 The review's primary task has been to investigate the graduate employment outcomes of those STEM disciplines that are judged to be of high value and important to economic growth and productivity, and to identify which of those disciplines have sufficiently poor outcomes to warrant further in-depth consideration through future targeted work. We have sought to gather a wide range of both quantitative and qualitative evidence to arrive at a list of disciplines that we recommend ought to be followed up. This has involved Higher Education Statistics Agency (HESA) data on graduate destinations at six months and three and a half years after graduation, feedback gathered through a wide ranging online stakeholder survey, discipline-specific stakeholder focus groups, written submissions of evidence from relevant professional bodies, and information gathered from wider literature on STEM skills and graduate employment outcomes and employability.

2.4 Based on the accumulated evidence we have arrived at a list of degree disciplines where the graduate employment outcomes are sufficiently concerning for us to recommend additional targeted work. The STEM disciplines that the review has identified as being of particular concern are:

- **Biological Sciences**[1]
- **Earth, Marine and Environmental Sciences**
- **Agriculture, Animal Sciences and Food Sciences**

[1] Further information on the list of sub-disciplines that form part of these 'headline' disciplines can be found at paragraphs 4.8-4.10.

The specific reasons behind why these disciplines exhibit relatively poor graduate outcomes have not been interrogated in detail and we have been clear that this is the role of the future targeted work to which we refer. However, in the course of the review's investigations, we have been able to identify some specific themes and issues that any future work will want to consider within its scope, and these are set out in more detail at Chapter 6.

2.5 In addition to the disciplines that we have identified as being of greatest concern, we have also identified a number of other disciplines where the evidence has pointed to some lower level concerns about graduate employment outcomes. Based on our investigations we are recommending that **Biomedical Engineering, Aerospace Engineering and Engineering Design** are investigated in more depth to develop a clearer understanding of the nature of their graduate employment outcomes. Following the initial interrogation of the available data, these disciplines were highlighted as being of concern and subsequent correspondence with relevant professional bodies has supported this view and strengthened our assessment that some further investigation should be conducted.

2.6 Alongside the identification of discrete disciplines where further work is merited, we have also identified a number of themes which appear to cut across the STEM landscape and which the evidence points to as having impacts of varying degrees on graduate employment outcomes. The **importance of graduates having had at least some work experience**, either through formal organised placements or informal mechanisms such as internships, has been a strong theme throughout the review. The value that employers place on **graduates being in possession of a strong set of 'soft' or 'work ready' skills** has also been prominent, with a large body of evidence pointing towards continued employer dissatisfaction with graduates in this respect. Neither of these themes are new revelations in the context of discussions on graduate employment outcomes, but the evidence suggests that more needs to be done to consider and address the challenges that they pose. The report makes two key recommendations focused on the need to think creatively about how additional opportunities for work experience could be opened up to students during their studies and how the development of soft skills could be embedded more systematically and robustly in degree curricula.

2.7 We have also heard evidence which suggests that in some cases, graduates may be suffering from sub-optimal employment outcomes owing to a **lack of awareness and understanding** about how the skills and knowledge they have developed during their degrees relate and map onto the jobs market. For a number of the STEM disciplines that we have investigated, clear links with the jobs market simply do not exist by virtue of the nature of the discipline. It cannot be said, for example, that graduates from Physics have a natural or typical industrial career pathway. There are a complex set of issues at play here, and part of our recommendation on this issue is that **careers advice should play a stronger role in STEM degrees** and that as a general principle **graduates ought to be encouraged to, and in practice, take greater responsibility for understanding, developing and engaging with their potential future career path**.

2.8 A distinct strand that has run throughout our investigations has been the **role that employer/HE sector engagement can play in informing and better aligning the supply and demand for high level STEM skills**. There is already a wealth of engagement – both formal and informal – that takes place between universities and employers with many

examples across the UK of strong partnership working. However, based on evidence around the continued concerns about STEM graduates raised by employers we suggest that **more could be done to encourage stronger collaboration between HE providers and employers to better align the supply and demand for STEM skills**. Different vehicles to support this collaboration are available, with the role of Industrial Advisory Boards (IABs) key in securing employer input into degree design.

2.9 The role that accreditation of degree programmes by professional bodies plays in ensuring employers are inputting into curricula is another mechanism for better aligning the supply and demand for STEM skills. Given the breadth of information and evidence that we have attempted to cover, detailed consideration of each of the accreditation frameworks underpinning the varying STEM disciplines has not been possible. We have, however, been able to make some high level observations. We have, for example, been able to identify that **accreditation offers one of the most important mechanisms for structured engagement between HE and employers** and that it should be taken seriously as a means to engender closer cooperation and a better fit between employer requirements and the skills and knowledge that the HE system has the capability to deliver. We have therefore recommended that where possible, **good practice from existing and well-established systems of degree accreditation should be shared more broadly across the STEM disciplines, and in particular with those disciplines where systems of accreditation are new and emerging. In this respect, we think that there is an opportunity for the Science Council to play a stronger role in overseeing the accreditation frameworks for the science disciplines** and that the experiences of the Engineering Council could provide helpful guidance in this respect.

2.10 Throughout our investigations we have been able to draw on existing data on graduate destinations from HESA to support our investigations. This has been supplemented by qualitative evidence gathered through an online stakeholder survey and discipline-specific focus groups. However, in order to develop a clearer and more sophisticated picture of why some graduates are securing better outcomes relative to others and to better understand the extent of the mismatch between the supply and demand for STEM skills, we **need access to richer and higher quality data**. Better mapping of data on work experience, together with the development of a framework for enabling better access to data on provision, take up and barriers to work experience, is one part of this. Another is developing a greater degree of granularity around data on graduate outcomes so that we can construct a more nuanced understanding of the factors that really make a difference. The lack of clear, accessible and detailed data on the nature of specific employer demands for STEM skills has been a constant challenge for the review and we recommend that there is more that employers should do to work proactively with education providers to understand and set out their skills requirements at sector-wide levels. There is also more that could be done to improve the data in terms of what it is able to tell us about the mobility of graduates and how they flow between industries and occupations of employment. The relationship between the skills that graduates have developed during their time in HE and the skills that they are required to adopt and exhibit whilst in employment is an additional avenue that could usefully be explored. Many of the challenges associated with enhancing the available data – and in some cases developing new sources of data – are significant. However, to ensure that we

are as clear as we can be about the factors that can influence graduate outcomes, and to make sure that any future interventions are the right ones, this is an area that needs to be considered seriously.

2.11 In conducting our investigations, and in developing our final recommendations, we have recognised the careful balance that needs to be struck between the role that HE plays in educating individuals for their own – and the UK's – benefit, and its role in contributing to the provision of the skills and knowledge needed to drive economic growth and productivity. Within the confines of the review we have not attempted to identify and draw the line between these two ideals, but recognise that there is a tension here to be managed. It is our view that it is not reasonable to expect that HE alone is well placed to equip students, not only with a robust intellectual grasp of the foundational academic principles of a discipline, but to also impart to them comprehensive knowledge of the world of work. Employers need to make sure that they are sharing some of the burden. The debate about where this balance lies is not a new one, and our calls for HE providers and employers to work closely in partnership to ensure that both ambitions are met are not unique or original. We have attempted, however, to highlight and reflect on areas where the relationship between HE and employers could best be harnessed to help improve outcomes.

The review's recommendations:

Recommendation 1 – Biological Sciences

Further targeted work is needed to explore in more detail the reasons for the relatively poor employment outcomes of Biological Sciences graduates and to set out solutions for improving these outcomes.

Recommendation 2 – Earth, Marine and Environmental Sciences

Further work is needed to unpick and explore the nature of, and reasons for, the relatively poor employment outcomes of graduates from Earth, Marine and Environmental Sciences (EMES) degree programmes. Where clear problems are identified for particular disciplines within the EMES group, solutions should be proposed for improving outcomes.

Recommendation 3 – Agriculture, Animal Sciences and Food Sciences

Further targeted work is needed to explore the current employment outcomes for graduates in these disciplines across the whole of the set of businesses in the agricultural-food chain. The existing data is not sufficiently detailed to allow certainty about the situation now and the pace of change in the industry is likely to place new pressures on both HE and the industry to match demand with the supply of appropriately skilled graduates. The study therefore needs to include consideration of the future as well as the past.

Recommendation 4 – Additional STEM disciplines of concern

Further targeted work is needed to explore the graduate employment outcomes of Aerospace Engineering, Biomedical Engineering and Engineering Design graduates. Within all three disciplines the respective industry bodies, HE providers and professional bodies for those disciplines should work together to clarify the nature of their graduate employment outcomes and decide whether specific measures are required to address the concerns we have identified.

Recommendation 5 – Increased engagement between industry and HE providers

Employers and HE providers should work more closely together in order to improve graduate employment outcomes. In particular, they should consider addressing the following areas:

- Improving the opportunities for students to take up work experience and to maintain its quality
- Embedding the development of soft skills into degree courses and improving work readiness
- Better matching degree courses to employer demand for skills
- Improving STEM careers advice and awareness of job opportunities for graduates and students, as well as even earlier in the education pipeline

Recommendation 6 – Improvements to data on graduate employment outcomes

There are opportunities to enhance the richness, quality and consistency of data available on STEM graduate employment outcomes. Ideally it should be possible for analysis of student flows from particular HE disciplines into specific sectors of employment to better recognise the type of degree and reflect upon relevant features of their degree programme. Where appropriate this should align with HESA's existing work to review graduate destinations and outcomes data. It should also extend beyond student data collections with the ambition that information collected from employers and their representative bodies can be available for scrutiny in an accessible and comparable form.

Recommendation 7 – Accreditation

Good practice from existing, well-established systems of degree course accreditation should be highlighted and disseminated where it may be of interest to those STEM disciplines without an accreditation framework or where an accreditation framework is emerging. Potentially the Science Council should explore a future role in developing and overseeing a unified accreditation framework for the science disciplines that draws upon the experience of both the Engineering Council and those science disciplines where there are already well-established accreditation systems.

3 Background and context

Why was the review commissioned?

3.1 The review was commissioned by Department for Business, Innovation and Skills (BIS) ministers following the publication of the Government's Science and Innovation Strategy[2] in 2014. One of the key priorities set out by the Strategy was to ensure that the science and engineering talent coming through the UK's educational pipeline was appropriately developed and nurtured and that, ultimately, it provided the UK with access to the skills and knowledge that it needs to continue to drive economic growth and innovation. With this in mind, the Strategy identified the need both to strengthen the supply of STEM skills coming through the education system, and to ensure that closer working and partnership between employers and universities helped to align better the supply and demand for STEM skills.

3.2 The Strategy built on earlier work looking at graduate employment outcomes which pointed to some concerning trends. In particular, it was found that graduates from certain STEM degree disciplines appeared to have particularly poor employment outcomes relative to other disciplines. In addition, it also highlighted that employers in some areas of the economy were reporting that STEM graduates required better employment-ready skills. The employment outcomes for Computer Sciences graduates were found to be particularly poor, with a long-standing and consistent pattern of higher than STEM-average levels of unemployment.

The nature of the problem

3.3 In many respects, and particularly in respect of employer concerns around skills gaps, this evidence built on existing and consistent evidence around the mismatch between the provision of, and the demand for, STEM skills. Many employers and employer representative groups have for a number of years reported difficulties in recruiting the skilled graduates that they need. Concerns have in some cases been directed at specific types of skill set, with much previous focus on graduates lacking the 'soft' and 'work readiness' skills needed to flourish in the workplace. Skills gaps have also been highlighted in relation to specific sectors, with the Manufacturing, Construction, Engineering, Pharmaceutical, and Computer Science-related industries all cited as examples of where STEM skills are not meeting the needs of employers.

3.4 In addition to concerns around the current alignment between the supply and demand for STEM skills, the importance of future trends in industry and the global economy has also been highlighted. A number of future trends and developments have been identified by organisations such as the UK Commission for Employment and Skills (UKCES) who have suggested that digitalisation of production, the age of big data and technologies that are increasingly converging and driving multidisciplinary working all need to be factored into the debate about the alignment between the supply and demand for STEM skills.

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2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

3.5 Rapid scientific advances and the advent of the digital age in particular provide the backdrop to a testing time for employers and the HE sector. HE providers face a tough challenge; they must provide graduates with up to date skills and knowledge that are relevant to employers today, while at the same time equipping them with the ability to continue to learn and adapt so that they can adjust effectively as the world and their careers change over a 50-year working lifetime. The latter point means that graduates in STEM must be given an understanding of the unchanging fundamentals of Science and not just its current applications.

3.6 The HE sector has worked to adapt its programmes and methods of teaching over the last two decades to equip graduates with soft skills and to try to address the requirements put forward by employers. However, they are not easily able to, nor – arguably – should they be required to, provide these skills by themselves. Employers, therefore, also have a responsibility to interact with HE as partners to instil the skills that they say they require in graduates. They also have a responsibility to train and develop graduates' skills and knowledge above and beyond what their education has provided them, providing real world experience that enables them to contribute effectively as quickly as possible immediately after joining an organisation. Furthermore, the provision of continuing education and training opportunities throughout a working life is an essential part of employment in the modern world.

3.7 These are neither new nor static concerns, and it is against this backdrop, and a view that more could be done better to understand the mismatch, that the previous Government commissioned two independent reviews to explore these issues in more detail. Professor Sir Nigel Shadbolt has been asked to undertake a targeted review into the employment outcomes for Computer Sciences graduates with a view to making recommendations aimed at improving outcomes. The second review – the subject of this report – is broader in scope and was tasked with exploring whether there are other STEM degree disciplines which suffer from poor graduate employment outcomes and whether certain disciplines would warrant similar, targeted Shadbolt-style investigation[3] in future.

Wider context

3.8 Work to develop a greater understanding of, and focus on, subjects of concern in HE is not a new development. Since 2005 the Higher Education Funding Council for England (HEFCE) has overseen work to support those individual degree-level disciplines which are deemed to be at risk and of strategic national importance. These Strategically Important and Vulnerable Subjects (SIVS) are overseen by a SIVS Advisory Group which determines the principles on which any potential intervention to support a discipline are based. In many ways, therefore, the work of this review builds on existing knowledge and seeks to develop thinking further.

3.9 Wider developments in the HE system have provided additional impetus to the reviews since they were initiated. In November 2015 the Government published its Green

3 http://www.hefce.ac.uk/kess/gradstemreview/csreview/

Paper, *Fulfilling Our Potential: Teaching Excellence, Social Mobility and Student Choice*[4] which, amongst a number of other proposed reforms, identified that considerations of graduate employment outcomes should inform thinking on quality and outcomes in HE. The proposed Teaching Excellence Framework (TEF), which will take much of this thinking forward, is still in development and the evidence gathered by the review will play an important part in helping to define the shape of the framework over the coming months. This review is not making specific recommendations in response to the Green Paper; however, many of the findings and issues raised by the report are likely to provide helpful context and additional evidence to support the work on TEF and other reforms as they progress.

The remit of the review

3.10 The primary aim of the Wakeham Review was to develop a clearer understanding of which STEM degree disciplines – alongside Computer Sciences – appear to suffer from particularly poor graduate employment outcomes and whether any of the disciplines identified would warrant investigation through targeted work similar to the Shadbolt Review. To meet this headline aim the Wakeham Review had a number of subsidiary objectives:

- To interrogate the data available on STEM graduate employment outcomes to identify whether individual STEM degree disciplines suffer from particularly poor outcomes relative to other disciplines and to identify the extent of the problem;
- To identify the potential factors that contribute to the observed outcomes and to come to a view on their relative significance;
- To come to a view on how systems of academic degree course accreditation and other assurance processes relate to, and impact on, graduate employment outcomes; and
- To include in its scope UK-domiciled graduates studying at publicly-funded English HE Institutions, and to exclude investigation of graduate outcomes from Scottish, Welsh and Northern Irish HE providers and Further Education Colleges (FECs).

3.11 The review's scope has been intentionally broad to allow us to assess graduate employment outcomes across a range of STEM disciplines. Investigating the reasons for particular employment outcomes for a discipline will be within the remit of any future work that arises from the recommendations of this review. This will likely include an interrogation of the employment outcomes of particular students according to equality groups, including gender, age, disability, ethnicity, and background (students from low participation neighbourhoods). However, while a detailed analysis of the outcomes for these groups of students has been outside the scope of this review, we recognise that evidence already exists that suggests that there are differential outcomes for these students regardless of the discipline they study and that this represents an area of

4 https://www.gov.uk/government/consultations/higher-education-teaching-excellence-social-mobility-and-student-choice

concern. Annex G provides information on the unemployment rate at six months for students from different equality groups from both the 2013-14 and 2010-11 cohorts, which demonstrates the type of analysis that any future discipline-specific work may wish to build on.

3.12 We also recognise that there are additional, strategic issues which, although related and of importance to the subject matter of the review, we have not been in a position to explore. For example, we have not sought to provide a commentary on the flow of STEM graduates into 'STEM' and 'non-STEM-specific' occupations. The report has been deliberately agnostic about where in the labour market STEM graduates find employment, either in terms of type of industry, geographic place of work, or whether, for example, they are going on to take up jobs in the UK or abroad. There are a number of complexities associated with these issues and it has not been within the review's scope to investigate these in detail. We are clear, however, that it is not for the HE system or accreditation to make specific recommendations about, or actively direct, the careers of individuals. It remains possible that the attractiveness of offers of employment in some 'non-STEM' sectors is likely to deprive traditional STEM sectors of some of the best and brightest STEM graduates, but it is neither feasible nor desirable for the UK to adopt a workforce planning approach to all areas and aspects of the economy. It is for relevant industries and sectors to consider and address these issues directly, and it should not be the preserve of the HE system or Government to interfere with those dynamics.

Accreditation

3.13 Within its remit, the review has been tasked with exploring the role of academic degree course accreditation and how, and if, this relates to graduate employment outcomes. The accreditation of degree programmes by professional, statutory and regulatory bodies (PSRBs) is one of the key mechanisms by which industry and the HE system interact; accredited programmes having demonstrated that they are meeting recognised standards – standards that in many cases are required for entry to particular professions.

3.14 The scope of the review has not allowed for deep investigation of the systems of accreditation for individual STEM disciplines, and, indeed, as the review has uncovered, the number of accreditation systems applicable to individual programmes in HE can, for some disciplines, be significant and lead to complexity. The review has been able to make some observations, however, about links between degree accreditation and employment outcomes and these are discussed later in the report.

3.15 In exploring the role played by accreditation, the review has been concerned specifically with accreditation of academic degree programmes. This is an important point to make, given that accreditation can also cover the recognition of an individual who is seeking to become registered in the field of a particular profession. The accreditation of individuals for the purposes of professional registration has not formed part of the remit of the review and is therefore not considered here.

3.16 At a high level, degree course accreditation is the process by which degrees are reviewed and judged as to whether they meet the published, defined standards set out by

the relevant accrediting organisation. It provides students, employers and wider society with a mark of assurance that the degree programme in question meets the standards set out by the accrediting organisation. Accreditation can have a number of linked benefits, in that it can:

- Satisfy the base academic requirement for registration as a professional
- Grant exemptions from all, or part, of professional examinations
- Provide some or all of the required knowledge for professional registration
- Provide entry to membership of a professional association/learned society
- Provide a public confirmation that HE providers are maintaining required standards and comparability with other degree programmes across the HE sector
- Assure employers that the graduates they recruit have met published standards
- Provide a benchmark against internationally respected standards

3.17 In many cases, employers and academics come together with the accrediting body to design the standards and in many professions both are part of the team of reviewers that visit HE providers to assess their degree programmes. Accreditation can therefore provide employers with a strong voice in decisions about accredited degree status. It represents a key mechanism through which employers can influence the design of degree programmes and an important way in which engagement between HE providers and employers is facilitated. It is this particular feature of accreditation that suggests it should be considered explicitly within this review.

3.18 Examples of how the Institution of Mechanical Engineers (IMechE) and the Royal Society of Chemistry (RSC) implement their systems of accreditation are set out as separate case studies at Annex C. In March 2011, the Higher Education Better Regulation Group (HEBRG) in collaboration with a number of partners produced a summary of the role that PSRBs play in HE, including how systems of accreditation contribute to provision. Further information on accreditation is, therefore, available in that paper[5].

Terminology

3.19 The importance of terminology has played a key role as the review has developed and clarity around the scope of what is, and is not, being investigated has been important. In high level terms, STEM degree disciplines are defined as those that fall within the broad categories of Science, Technology, Engineering and Mathematics. Given the range of degree disciplines provided by HEIs that could be categorised under these broad headings, to bring focus to the investigation the review was required to direct its work at the STEM disciplines that are deemed to be of high value and critical to building and supporting a knowledge-based economy.

5 http://www.universitiesuk.ac.uk/highereducation/Documents/2011/HEBRG_ProfessionalBodies.pdf

3.20 Inevitably, a precise definition of high value STEM is not possible so we have used a degree of judgement about disciplines, seeking to include within the scope of investigation those STEM disciplines that are mainly focused on the private economy, where the labour markets are not primarily funded by the taxpayer and which are not subject to number controls in HE. This has excluded from the scope of the review's investigation disciplines related to, for example, healthcare, including those linked to clinical medicine and allied health professions.

3.21 It is also important to distinguish the terms 'employment' and 'employability'. We have been clear during the course of the work that 'employment' and 'employability' remain two fundamentally separate concepts. Just because a graduate is unemployed does not mean that they are unemployable. Employability is patently a more fluid and complex concept. In its recent occasional paper[6], the Higher Education Policy Institute (HEPI) highlighted the different views on employability and the difference between 'fixing' employment outcomes that remain a snapshot in time, versus taking steps to '*enhance the students' long-term value and resilience in the workplace, [and] their ability to achieve their best-fit career*'. HEPI goes on to define employability as being composed of: knowledge, skills and social capital. This review has been clear that it is not seeking to define employability, or to use it as the sole basis on which to investigate STEM disciplines. Some of the findings of the review – particularly those arising from the survey – relate to elements of employability – for example soft skills – but the primary basis for investigation has been focused on employment outcomes of STEM graduates.

The strategic importance of STEM skills

3.22 Every country in the world recognises the need to develop a skilled workforce and knowledge base that will drive economic growth and scientific and technical innovation. To that end, all countries are searching for the best talent and are seeking to recruit the highest skilled STEM workers. To ensure that it can succeed in this increasingly competitive global economy, the UK needs to ensure that it has access to a sufficient supply of high level, economically valuable skills[7]. Whilst there is an increasingly global marketplace for skills, with the free movement of labour between the world's economies, it is clearly sensible to try to ensure that we are properly equipping our domestic workforce to meet the needs of employers and to drive growth. A key pillar in ensuring long term UK economic resilience is establishing a robust and solid domestic base of highly-skilled STEM workers.

3.23 The argument that STEM skills are vital in driving growth, productivity and innovation requires little introduction. There is much strong evidence to indicate that STEM skills and industries are closely linked with positive economic performance. Numbers of STEM graduates are, for example, strongly correlated with innovation. Around 45% of graduates working in innovative firms in manufacturing and knowledge-

6 http://www.hepi.ac.uk/2015/12/10/employability-degrees-value/

7 UK ranks 7th on the INSEAD (International Business School) global talent competitiveness index – which takes account of a wide range of factors from quality of education at all levels to the extent to which the regulatory framework facilitates talent development. The UK is behind USA, Canada and Singapore, but ahead of many EU competitors.

intensive business service industries had a degree in a STEM subject, compared to only about 30% of graduates in non-innovative firms[8]. Data from UKCES and Labour Force Surveys[9] points out that there is an association between hourly pay and the use of STEM skills in the workplace, which suggests that STEM skills play a part in increased earnings and productivity. There is also much evidence to suggest that students who study STEM disciplines at university go on to enjoy higher earnings: six months after leaving HE, the median salary of STEM graduates was £1,500 (or 7.5%) higher than that of non-STEM graduates at £21,500, compared with £20,000[10].

3.24 It is also clear that the world continues to change and evolve at an ever increasing pace. Technological and scientific advancements are changing the world of work, and it is evident that a number of STEM disciplines are likely to be fundamental to this change. Previous work in partnership between Government and industry and education has highlighted key sectors and industries where the most significant benefit in terms of economic growth and productivity may be derived. There is a range of different views on the most effective taxonomy to describe these growth areas, but the following broad sectors are often cited as of critical importance to the UK's future industrial strategy:

- Aerospace
- Agricultural Technologies
- Automotive
- Construction
- Information Economy
- International Education
- Life Sciences
- Nuclear
- Offshore Wind
- Oil and Gas
- Professional and Business Services

3.25 At the heart of many of these growth sectors are often new and emerging technologies which are transforming the productivity and economic potential of the UK. The advent of big data, synthetic biology, new agricultural technologies, energy storage, and robotics are technologies that have all witnessed growth and advances in recent years and which will be important to the futures of many of the sectors and industries that the UK economy depends on in the coming years.

8 Levy and Hopkins, 2010 as cited on pg. 2, UKCES *Reviewing the requirement for high level STEM skills.*

9 *Reviewing the requirement for high level STEM skills* (UKCES; 2015) – page 6.

10 HEFCE analysis of responses to the 2013-14 Destination of Leavers from Higher Education (DLHE) survey. UK-domiciled full-time first degree qualifiers in 2013-14 academic year who provided a valid response to the survey which indicated that they were employed in full-time paid UK employment, and who provided information on their salary. For the purposes of this report, STEM includes qualifiers from agriculture and forestry subjects. If agriculture and forestry were not included, the STEM median salary was £22,000 while the non-STEM median salary remains £20,000.

3.26 A majority of these sectors and emerging technologies are characterised by a strong reliance on high level STEM skills. Furthermore, many are characterised by their multidisciplinary nature; relying on skills and knowledge from across the STEM spectrum. It is crucial therefore that the UK has a robust pipeline in place that can effectively meet the continuing and evolving demand from industry for high level skills and a HE sector that is keeping pace with an increasing need for people with the ability to work in and across multidisciplinary teams.

Key features of the current STEM landscape – higher education and industry

3.27 Before setting out the approach that the review has taken and its findings, we provide some background on some of the key features of the current STEM landscape, from the perspectives of both the HE system and industries that recruit and rely on high level STEM skills.

HE provision

3.28 It is important to acknowledge that, from a supply-side perspective, STEM provision has come a long way in the past few years. Significant efforts have been invested by the HE sector, successive Governments, industry and a range of professional bodies to boost the numbers of students studying STEM subjects. Until recently the UK struggled with a problem essentially of undersupply, with the HE system failing to attract enough students to take up STEM courses. This has been recognised as an issue of concern for other European countries, with Eurostat reporting the number of science enrolments and graduates in Europe as a proportion of all subjects reducing over the decade from 2002, declining from 24.3% in 2002 to 22.6% in 2011[11].

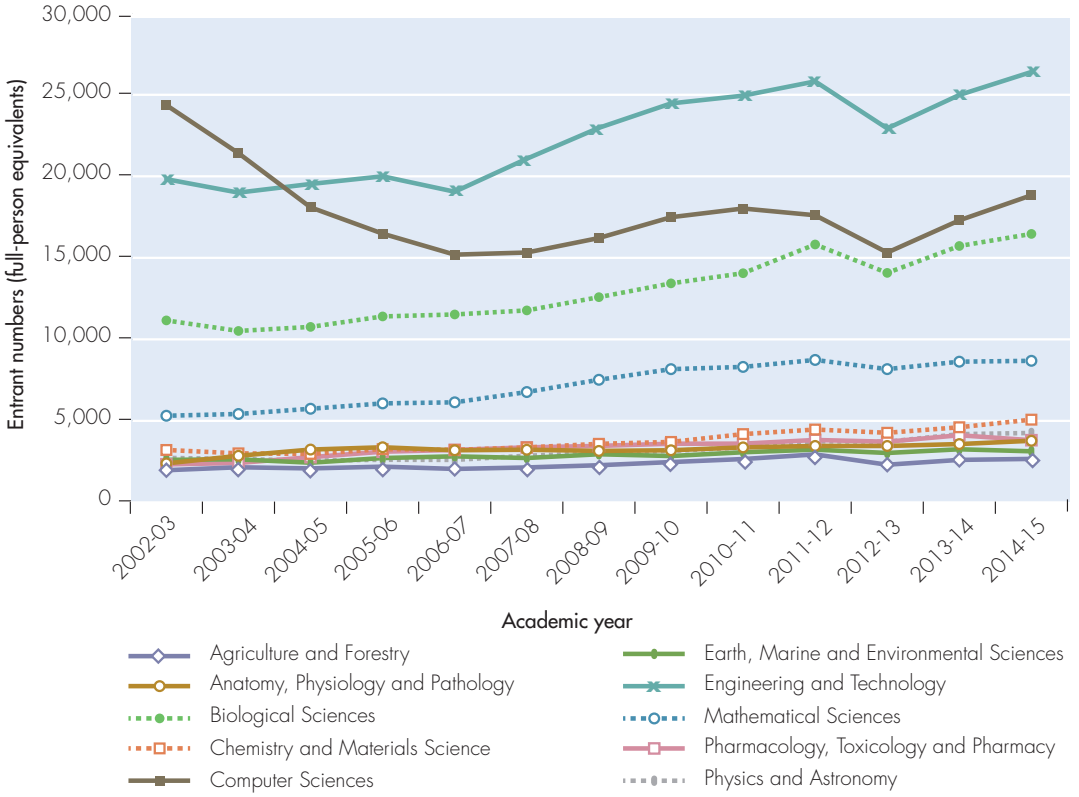
3.29 In the UK, much effort has been directed at trying to improve this situation, with HEFCE's work on SIVS illustrative of the concerted partnership effort made to boost the profile and take-up of STEM degrees. Initiatives such as the annual Big Bang UK Young Scientists & Engineers Fair[12] have also played an important role. Although falling in 2012-13 (in line with an overall decline in response to the fee reforms), numbers of full-time undergraduates starting STEM courses have increased steadily over the past decade, with numbers in 2014-15 around 30% (22,000) higher than in 2006-07, at around 98,000. More widely, Government has taken additional action to improve STEM uptake, opening up access to tuition fee loan support for those pursuing second STEM degrees. We must not, however, be complacent. Despite recent improvements, demographic changes and the changing perceptions of potential students are still issues and so we must continue to be vigilant and maintain the efforts that have proved successful to date.

3.30 The charts below provide a summary of information relating to STEM and individual discipline-level numbers of entrants, graduates, unemployment rates and employment outcomes.

11 http://www.educationandemployers.org/wp-content/uploads/2014/06/joyce_-_stimulating_interest_in_stem_careers_among_students_in_europe.pdf

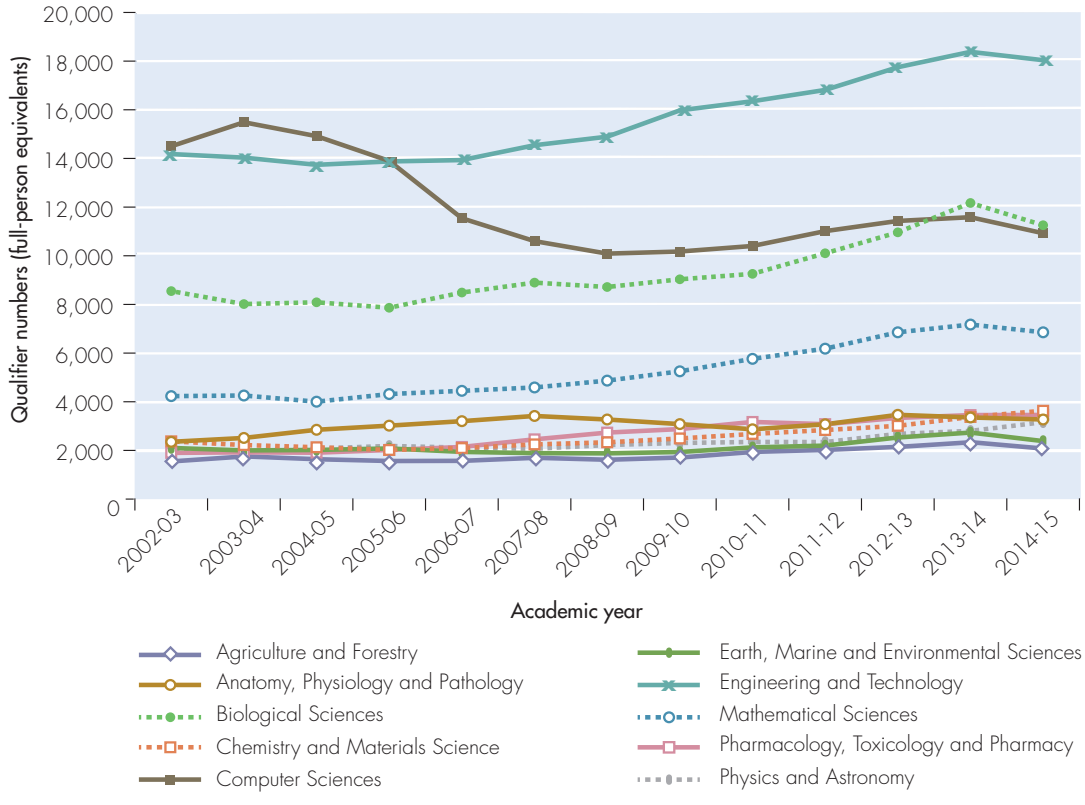
12 https://www.thebigbangfair.co.uk/

Figure 1 Numbers of full-time first degree entrants to STEM subjects (including Agriculture and Forestry): entrants to publicly-funded English HEIs by STEM discipline, 2002-03 to 2014-15



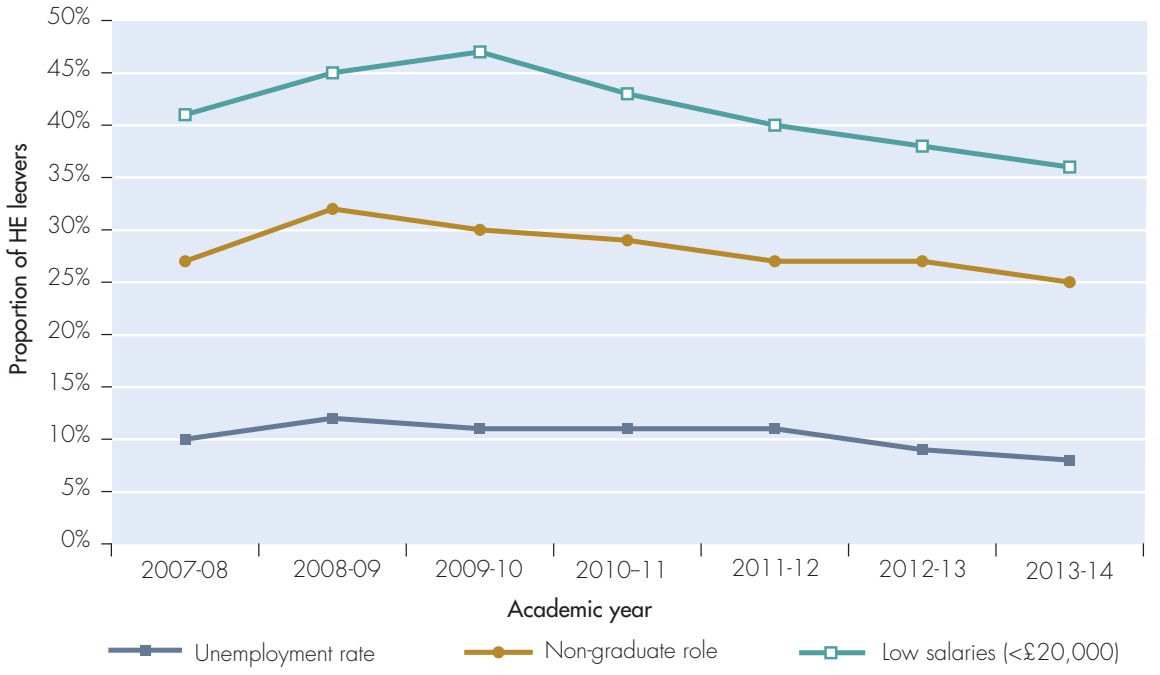
Source: HEFCE analysis of the Higher Education Statistics Agency (HESA) standard registration population, 2002-03 to 2014-15.

Figure 2 Numbers of full-time first degree graduates from STEM subjects (including Agriculture and Forestry): graduates from publicly-funded English HEIs by STEM discipline, 2002-03 to 2014-15



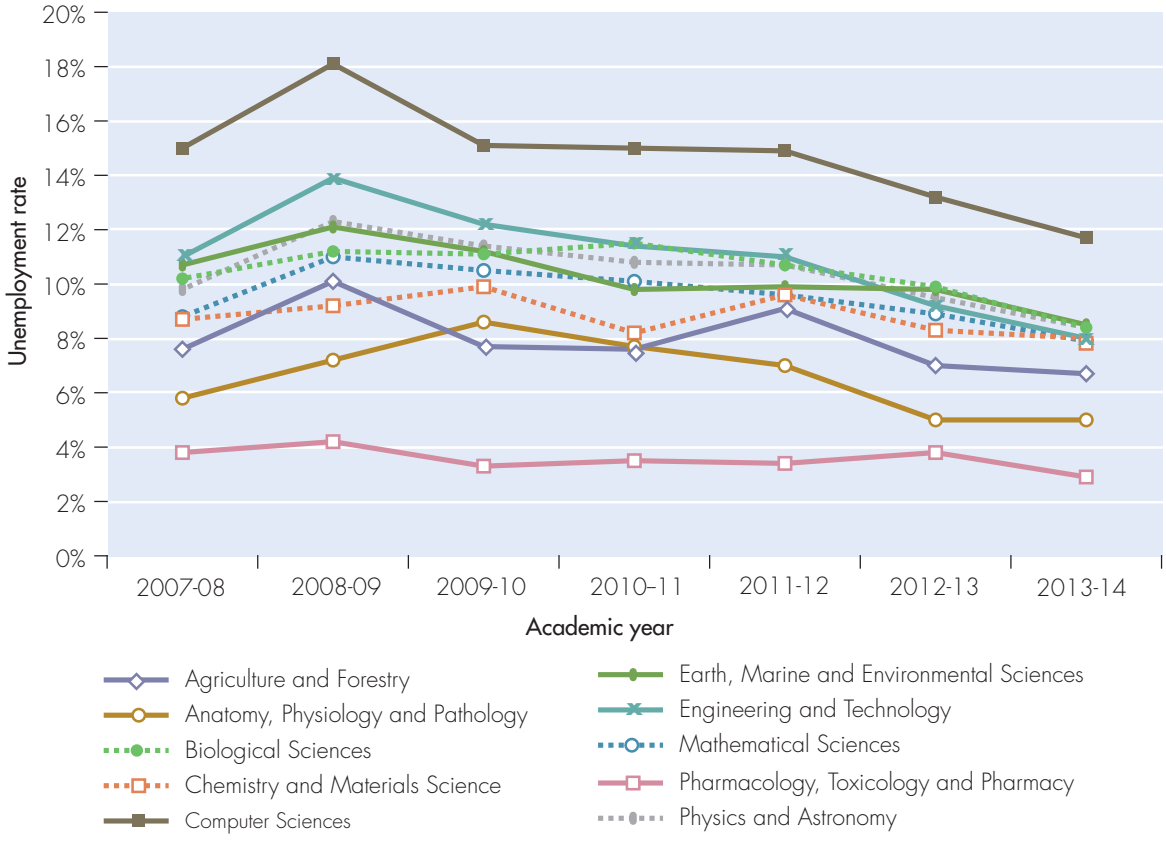
Source: HEFCE analysis of the HESA standard qualifications obtained population, 2002-03 to 2014-15.

Figure 3 Employment outcomes of UK-domiciled full-time first degree graduates from STEM subjects (including Agriculture and Forestry) six months after leaving HE: graduates from publicly-funded English HEIs by employment measure, 2007-08 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2007-08 to 2013-14. Graduates who subsequently provided a valid response to the Destination of Leavers from Higher Education (DLHE) survey six months after leaving HE.

Figure 4 Unemployment rates of UK-domiciled full-time first degree graduates from STEM subjects (including Agriculture and Forestry) six months after leaving HE: graduates from publicly-funded English HEIs by STEM discipline, 2007-08 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2007-08 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

3.31 It is also important to say something of the postgraduate STEM landscape. Whilst the focus of the review has been on developing a clearer understanding of the employment outcomes of the STEM undergraduate population, more ought to be known about how postgraduate study relates to the wider skills and employment debate. For a number of STEM degree disciplines, often the recognised and traditional route into employment for graduates is through further, specialist postgraduate study. Evidence submitted to the review suggests that Pharmacology and Toxicology are two such areas. One of the issues that the review has picked up is that information on the employment outcomes of taught masters programmes is limited even though many are explicitly aimed at particular employment markets. Whilst more accessible data is available on the outcomes of students studying integrated masters degree programmes (for example through information outputs published for prospective students such as the Key Information Set, KIS), further analysis of the routes into employment of taught masters students would help to improve our understanding of how STEM HE provision relates to labour market demand.

Industry

3.32 Employer concerns around graduate skills gaps are not new. The review's investigations have taken place in a context of much existing evidence that points to a mismatch between the skills that employers say that they need and the graduate skills coming through the HE system. In the 2015 survey of employers, the Confederation of British Industry (CBI) found that 34% of businesses said that the quality of STEM graduates was not good enough and 46% said they lacked experience in the workplace. In its 2013 Employer Skills Survey Report[13], the UKCES reported on some graduates being poorly prepared for work and that in some areas 'recruits lacked experience of the working world or experience of life in general.'

3.33 While these concerns relate to longstanding themes around soft skills, concerns have also been raised in relation to skills gaps in specific industrial sectors. The Association of the British Pharmaceutical Industry (ABPI) has previously reported substantive skills deficits in the areas of Biomedical Sciences, Clinical Pharmacology and Drug Metabolism. In the Engineering sphere, Engineering UK's 2015 report on the state of Engineering suggested a number of common problems including 'A lack of general workplace experience among applicants (39%)' and 'weaknesses in the attitudes and aptitudes for working life among candidates (30%)'. The 2015 CBI/Pearson Education and Skills Survey[14] highlights Manufacturing, Construction and Engineering, Science and Hi-Tech as sectors which are particularly struggling to recruit the STEM skills that they need across all levels: apprenticeships, technicians, graduates, experienced staff. It notes that the manufacturing supply chain is particularly at risk of skills shortages, with smaller firms finding it particularly difficult to recruit the necessary skills.

13 https://www.gov.uk/government/publications/ukces-employer-skills-survey-2013

14 http://news.cbi.org.uk/reports/education-and-skills-survey-2015/education-and-skills-survey-2015/ – Chapter 3, page 22

3.34 Alongside concerns about current skills gaps, any investigation also needs to take account of the trends that are likely to shape the future demand for skills. The industrial context in many areas of the UK, and indeed the global, economy is changing rapidly which will in turn have an impact on the skills employers require. In many areas, the rate of change of the application of scientific and technical knowledge to industry has never been quicker. The UKCES[15] has identified a number of trends that it suggests will play a significant part in shaping future skills needs:

- Converging technologies and cross-disciplinary skills
- Digitalisation of production
- ICT development and the age of 'Big Data'
- Shift to Asia: offshoring and outsourcing of jobs meaning increased competition for UK businesses
- New business ecosystems
- Growing scarcity of natural resources and degradation of ecosystems
- Changing work environments and flexible workforces

> **"Industries with the strongest requirement for high level STEM skills include research and development in fast moving scientific disciplines; technical consultancy activities that are central to the performance of the production sector of the economy; activities that are core to the information economy, including computer programming; and niche manufacturing activities that draw on a high level of scientific knowledge."**
>
> Reviewing the requirement for high level STEM skills (UKCES 2015)[16]

3.35 Whatever the shape and prevailing trends around the future demand for STEM skills, it is clear industries will continue to change and evolve. In line with this, graduates will not only require the skills to enable them to thrive in today's job roles, but they will also require the ability to evolve and adapt over a lifetime of work. Even if a graduate remains with the same company for a long period they may find their original role disappearing and being replaced with a new one which presents them with a whole set of new skills challenges. Graduate adaptability and resilience is a theme that the review has encountered on a number of occasions in its investigations and which will be explored in more detail later.

3.36 One observation that the review has made is that the expectations of industry, and in particular its expectations of graduates, have changed over time. Many employers are increasingly seeking graduates who are able to make a positive and identifiable contribution to the business from day one. Some evidence suggests that employers are tending to devote fewer resources to 'on the job' training, increasingly relying on 'oven-

15 https://www.gov.uk/government/publications/high-level-stem-skills-requirements-in-the-uk-labour-market

16 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444048/High_level_STEM_skills_requirements_in_the_UK_labour_market_FINAL.pdf

ready' graduates to hit the ground running. UKCES found that, between 2011-13, although there had been an increase in the total number of staff trained over a 12-month period, there had been a marked fall in the average number of training days provided to each person trained, resulting in a slight fall in the net number of total training days funded or arranged by UK employers.[17] In view of the continuously changing nature of industry and the need for graduates to upskill and adapt their knowledge as their working lives progress, this is an important point. The UKCES's 2015 Employer Skills Survey highlights the need for continuing business investment in developing workforce skills:

> **"That training levels have broadly remained consistent is positive given the constraints businesses have faced in recent years, but it does also pose a challenge to UK businesses. Around 90% of the current labour force have the potential to be active in the labour market a decade from now. Therefore, the economy cannot rely on initial education alone to ensure people have the continuously changing skills that are needed: the workplace is a vital location to develop these skills. Given the importance of skilled people as a global currency, the survey poses questions about whether these levels and the types of training businesses are investing significant resources in are adequate to enable the UK economy to take advantage of opportunities, capitalise on innovation and secure growth in performance and productivity."**

3.37 One of the possible drivers of the apparent change in industry expectations of graduates is that the structure and nature of UK industry has itself changed over time. The review's scope did not extend to conducting an in-depth analysis of the structures and make-up of those industries that recruit from the disciplines that are considered as part of this review. However, the review would submit that many sectors of industry, especially those with a great reliance on STEM graduates, have a significantly smaller number of large-scale employers than in the past and a significantly greater proportion of small and medium-size employers who may form part of a supply chain to a larger entity. Although many large-employers still deliver large-scale training programmes to the significant number of graduates they recruit from the HE system, the practice is not as commonplace as it once was and for medium-sized employers such training courses are often not feasible. For high-growth, high technology activities, especially in areas such as IT and computing, pharmaceutical development, synthetic biology and specialised materials, there is now a raft of 'start-ups' and micro-businesses. These companies are in many cases at the forefront of research and innovation; however, given their size and resource many of them are not able to take on and upskill graduates in a way that replicates that practised by larger companies. The changing structure of industry, therefore, has implications for the HE sector, with an increasing proportion of employers lacking the resource, finance and capability to invest in traditional graduate recruitment and training mechanisms.

17 https://www.gov.uk/government/publications/ukces-employer-skills-survey-2013

3.38 It is also important to take account of the wider international context for STEM skills and recognising that the UK is not alone in suffering from those problems. Evidence suggests that STEM skills are in high demand across Europe and beyond and that many economies continue to struggle to secure the high quality skills and knowledge that they need to drive economic development. Concerns appear to centre on both the mismatch between the supply and demand for STEM professionals and the type and quality of STEM graduates that employers have access to. According to the European Schoolnet Report, *Stimulating Interest in STEM Careers among Students in Europe: Supporting Career Choice and Giving a more Realistic View of STEM at Work*,[18] by 2020 more than 800,000 technology posts across Europe will be unfilled due to skills gaps. It also suggests that European economies are struggling to secure skilled graduates in specific areas, with computer science, physics and engineering noted as particular concerns.

3.39 Significantly, in the context of this report's findings on the graduate employment outcomes for Earth, Marine and Environmental Sciences, according to the European Union (EU) Skills Panorama (2012), increasing demand for 'green engineers' appears to be a feature of the wider landscape. This demonstrates that there are potentially wider, systemic issues across Europe in the relationship between HE and industry.

3.40 The review has, in its investigations, found it challenging to provide a comprehensive and meaningful summary of the shape and requirements of those industries that draw heavily on the skills of STEM graduates. In practice we know that STEM graduates go on to take up jobs in a huge variety of different sectors and industries ranging from financial and professional services, health services, manufacturing industries, and the pharmaceutical industry. During the course of the review it has also become clear that in most cases industries and sectors do not align neatly with the categorisation of STEM disciplines that are used by HE providers and that have been used by the review as the basis for its investigation. This is a challenge which the review has grappled with throughout its work and which is addressed later.

18 http://www.educationandemployers.org/wp-content/uploads/2014/06/joyce_-_stimulating_interest_in_stem_careers_among_students_in_europe.pdf

4 Methodology

4.1 The review has set out to understand whether graduates from particular STEM disciplines suffer poor employment outcomes relative to graduates from other disciplines. The review's scope includes STEM provision and the employment outcomes of UK-domiciled graduates from undergraduate degree programmes at publicly-funded HEIs in England. The review has, therefore, not explored the outcomes of graduates studying at Northern Irish, Scottish or Welsh universities, or those studying at alternative providers of HE or further education colleges (FECs). However the findings will be relevant for all HE providers that offer STEM provision

4.2 In order to represent disciplines, the review has used subject categories developed and refined by HEFCE as the starting point for determining which subjects should be considered as part of the review. The difficulties in reaching an agreed definition of STEM and the subjects that fall within this group were covered in the 2012 House of Lords Science and Technology Select Committee inquiry into HE in STEM subjects. This acknowledged that the definition of STEM subjects '*varied between different bodies within and outside Government and also from country to country (making comparisons about the number of STEM graduates difficult)*'[19]. In response to the inquiry, the Government recognised the possibility of confusion caused by having different definitions of STEM; however, it highlighted that these are designed for different purposes by different organisations. The review recognises that even within a given audience, the term can be applied differently to accommodate different contexts and purposes for which it is being used. For example, a definition used for a specific HE funding initiative may legitimately differ from a definition employed within a report on educational standards or workforce skills needs. Equally, definitions of STEM used in the HE sector will not neatly match those used by employers or recruitment agencies. One single definition for all purposes is therefore unsuitable.

4.3 In agreement with its Advisory Group, and in line with its remit, the review therefore focused attention on those STEM disciplines within the HEFCE STEM subject group that are deemed to be of 'high value' and critical to building a knowledge-based economy. In following this approach, the review has not attempted to develop a precise definition of, or fixed criteria for, 'high value' disciplines. Instead the review has applied a common sense approach, focusing on those STEM disciplines that are mainly directed to the private economy and which are associated with labour markets which are not primarily funded by the taxpayer. The review therefore excludes disciplines that are subject to number controls, such as Medicine and Dentistry as well as broader allied health disciplines and nursing, on the basis that the private, high value, growth areas of the UK economy do not rely directly on graduates from these disciplines.

[19] *Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects* – Science and Technology Committee http://www.publications.parliament.uk/pa/ld201213/ldselect/ldsctech/37/3705.htm

4.4 Given this focus on the contribution of high value disciplines to economic growth, the review has also considered subjects within the HEFCE Agriculture and Forestry broad subject group. Since 2013, HEFCE demand data has designated Agriculture and Forestry as a separate subject group, recognising that the subjects within the group are diverse and that the STEM content within some of those subjects is considerable. The inclusion of the Agriculture and Forestry group within the scope of the review recognises the important role that graduates from a number of those subjects play in contributing to the development of the current and future UK economy. The full list of STEM disciplines in scope for this particular review is provided in paragraph 4.10 below.

4.5 The review has gathered and analysed a large body of evidence through engagement with a broad range of representatives from the HE sector, students, employers, and PSRBs and representative organisations. This has included an online survey, focus groups and invitations to specific bodies to provide their views on the reasons for the employment outcomes of graduates from particular STEM disciplines. The review has analysed quantitative data, in the form of graduate destinations data – the Destinations of Leavers from HE (DLHE) and the Longitudinal Destinations of Leavers from HE (LDLHE) survey – which are collected by HESA. It also conducted a desk-based literature review to gather any additional material from existing reports and publications on topics relevant to the review's remit.

4.6 The breadth of evidence gathered was important to help ensure that the review was able to develop and understand the true picture of graduate employment outcomes across all STEM disciplines. While this picture is clearly framed by an analysis of the data available through graduate destinations surveys, it is important that a robust analysis of the landscape is supported by contextual, qualitative evidence from stakeholders. Data from the destinations surveys on the take up of work experience during their undergraduate programme, for example, is currently limited to those students who are undertaking a year-long formal sandwich programme.

Approach to evidence gathering

4.7 The review has broadly been structured around three stages of evidence gathering and analysis. These stages are summarised below and each is described in more detail later on:

STAGE 1 – Scope of review defined; in depth analysis of data on graduate destinations; online survey

The purpose of this stage was first to agree the disciplines that should be considered within the scope of the review. Data on the destinations of graduates from the disciplines within scope of the review was then interrogated to assess graduate employment outcomes. The criteria for this assessment were based on three employment indicators: unemployment rate; proportion of graduates in non-graduate roles; and proportion of graduates earning low salaries. Alongside the analysis of destinations data, stakeholders were invited to contribute their views on the employment outcomes of STEM graduates through an online survey. The results of both the graduate destinations data analysis and survey responses were then compared and used to inform Stage 2 of the review.

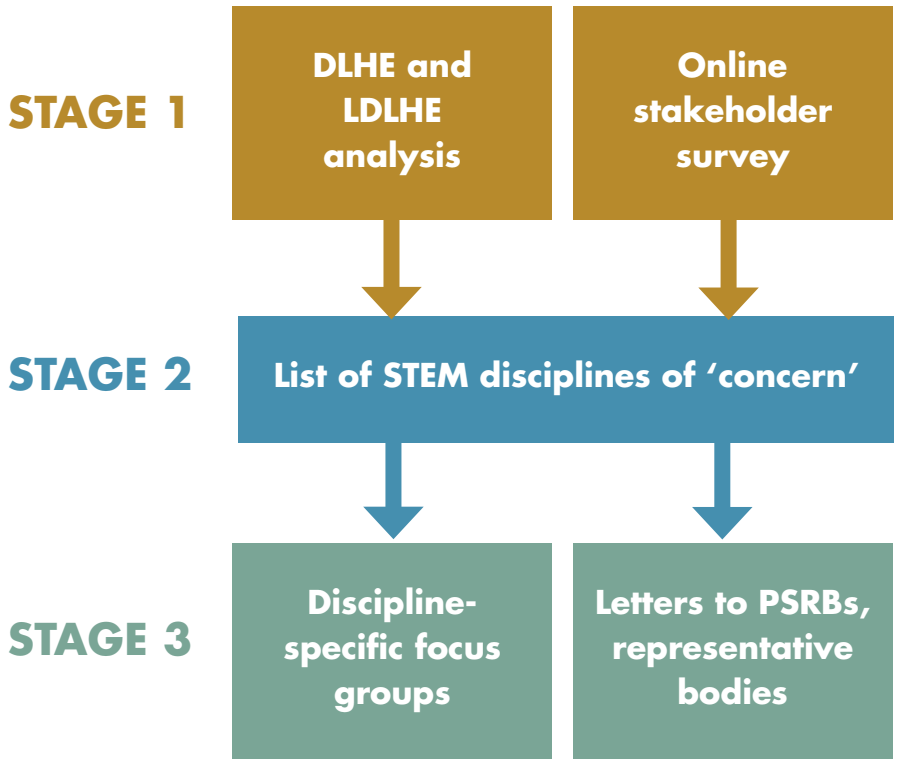
STAGE 2 – Identifying a list of STEM disciplines where there appeared to be valid grounds for concern about graduate employment outcomes

The purpose of this stage was to review the two separate sets of analyses from Stage 1 of the review. The analysis of the quantitative data on graduate destinations was compared to the qualitative evidence gathered through the stakeholder survey to identify where there may be coincident findings that pointed to particular STEM disciplines of concern. Once disciplines of concern had been agreed on the basis of this comparison, each discipline was then looked at in greater detail in Stage 3.

STAGE 3 – Focused investigation of STEM disciplines of concern, including running focus groups and consulting PSRBs and representative organisations

The purpose of this stage was to develop a more nuanced understanding of whether there were justifiable grounds to recommend that further work be taken forward to investigate the employment outcomes of graduates from the STEM disciplines identified at Stage 2. This included running discipline-specific focus groups based around those disciplines that were flagged as of greatest concern from the Stage 1 analysis. For those disciplines where there was a lesser level of concern, the review consulted with a range of relevant PSRBs, inviting their views on the employment outcomes of graduates from these disciplines.

Figure 5 Review approach and evidence gathering



STAGE 1 – Scope of review defined, in depth analysis of data on graduate destinations; online survey

Definition of scope

4.8 There is a range of interpretations among employers, the HE sector, Government and representative bodies on how the group of STEM subjects is defined and therefore which disciplines are included within the broad definition. As outlined above, the review has used HEFCE subject groups to categorise the complete discipline set from which we have extracted for study in the review those that have a direct high-value impact on the economy.

4.9 HEFCE subject groups have been modified and refined over several years to provide a coherent analytical framework for subject-based data analysis. This has been particularly important given the range of disciplines within the HE system and to ensure validity of data analysis where there are small numbers of graduates and/or a small number of valid responses to the destinations surveys. Annex F provides more detail on the breakdown of subjects that fall within the STEM and Agriculture and Forestry HEFCE subject groups that we consider. The Annex includes how they relate to the codes used by HEIs in the Joint Academic Coding System (JACS) and in the provision of data to bodies such as HESA, HEFCE and UCAS.

In depth analysis of data on graduate destinations

4.10 Based on the remit of the review, the following list of subjects were agreed to be in scope:

Agriculture and Forestry

Anatomy, Physiology and Pathology

Biological Sciences, encompassing:

- Biology
- Botany
- Agricultural Sciences
- Forensic and Archaeological Sciences
- Genetics
- Microbiology
- Molecular Biology, Biophysics and Biochemistry
- Zoology
- Others in Biological Sciences

Chemistry and Materials Science

Earth, Marine and Environmental Sciences, encompassing:

- Geology
- Physical Geographical Sciences
- Sciences of Aquatic and Terrestrial Environments

Engineering and Technology, encompassing:

- Chemical, Process and Energy Engineering
- Civil Engineering
- Electronic and Electrical Engineering
- General Engineering
- Mechanical, Aero and Production Engineering
- Minerals, Metallurgy and Materials Engineering
- Others in Engineering and Technology[20]

Mathematical Sciences

Pharmacology, Toxicology and Pharmacy

Physics and Astronomy

4.11 Using this list of disciplines, the review then considered data available through HESA surveys of graduate destinations. These surveys provide information on what graduates from HEIs are doing following their studies, including whether they are in employment, the type and location of employment, whether they are undertaking further study, or if they are unemployed. They therefore provide a rich source of information on the outcomes for graduates. Data available through two surveys was considered:

- DLHE survey – all recent UK graduates are invited to respond to this survey which is returned by students approximately six months after graduation. The survey is locally managed by HEIs using a centrally defined survey instrument. Graduates' responses are submitted to HESA's DLHE data collection. Data used in this review report relates to **valid** responses received to the DLHE survey[21].
- LDLHE survey – a sample of graduates who provided a valid response to the DLHE survey are invited to respond to this survey which is collected 40 months (or three and a half years) after graduation. This provides an indication of whether employment outcomes persist into the longer term. Data used in this review report relates to **valid** responses received to the LDLHE survey.

20 Description of 'others in engineering and technology': miscellaneous grouping for related subjects which do not fit into the other engineering and technology categories examined; this includes naval architecture and maritime technology as well as engineering subjects not elsewhere classified (which HEIs are directed to use sparingly).

21 A small number of students respond to the DLHE and LDLHE surveys with their explicit refusal to complete the survey.

4.12 Further information on the destinations surveys, and how the data that they provide has been used to interpret employment outcomes, is included at Annex D.

4.13 To assess the employment outcomes of STEM graduates, analysis of the six-month destinations data was undertaken using the following three key indicators:

- proportion of graduates unemployed;
- proportion of graduates in 'non-graduate' roles; and
- proportion of graduates earning less than £20,000[22].

4.14 The definition of non-graduate roles adopted by the review is one that identifies non-graduate roles as being those that fall outside of the three Standard Occupational Classification (SOC2010, defined by the Office for National Statistics)[23] major groupings of 'managers and senior officials', 'professional occupations' and 'associate professional and technical occupations'. It is important and reasonable to note that there are – within existing literature and studies on graduate employment – a range of definitions available to categorise whether roles are graduate or non-graduate in nature, and that there is no one commonly accepted definition, which poses a challenge to any assessment using this criterion. The review has been required to adopt one of the available definitions to take its investigations forward: the adopted definition has the benefit of simplicity and transparency and is in line with the definition used in other outputs (for example in the Key Information Set, KIS). In using the above definition to help us come to a view on disciplines of concern, we have been aware of some of the challenges associated with its use in relation to specific disciplines. However, based on the additional evidence that we gathered from sources other than the DLHE and LDLHE surveys – the online stakeholder survey and focus groups, details of which are set out below – we have concluded that altering the definition of 'non-graduate' job would not materially alter our conclusions on the STEM disciplines of concern.

4.15 To consider the impact on employment outcomes of the type of HEI where a student has chosen to study, data was assembled for four groups of HEIs. Specialist institutions were separated out into their own category. Then three further groups were formed based on the average UCAS tariff for young undergraduate entrants. These groups were high tariff, medium tariff and low tariff.

4.16 Throughout the data analysis considered by the review all percentages based on fewer than 22.5 qualifiers have been suppressed. The provisions of the Data Protection Act 1998 lead HEFCE to implement a strategic approach to the publication of data and analysis, designed to prevent the disclosure of personal information about any individual. This strategy involves rounding all numbers to the nearest multiple of five,

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22 The median salary for all UK domiciled leavers who obtained first degree qualifications and entered full-time paid work in the UK was £20,000 (in each of 2011-12, 2012-13 and 2013-14 graduate cohorts). The equivalent median salary among leavers from 'science subject areas' is £21,000. See tables 6 and 7 at https://www.hesa.ac.uk/index.php?option=com_content&view=article&id=1899&Itemid=634#salary

23 http://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc/soc2010
https://www.hesa.ac.uk/component/content/article?id=102&ItemId=136&limit=1&start=12

and suppressing percentages based on small populations. The latter also helps to reduce the potential for a single individual to exercise a disproportionate effect on a summary statistic[24]. It is considered that measures calculated on the basis of a population whereby significant sways can arise from the contribution of a single individual are not statistically robust, over time or for the purposes of comparison, and heighten the risks of misleading or misinterpreted findings.

4.17 The approach taken to interpreting the differing employment indicators was as follows:

- The three key indicators defined in 4.13 were calculated separately for graduates from each of the STEM disciplines, as well as for the totality of STEM provision.
- Within each discipline (including STEM in its totality), the three indicators were then calculated separately for graduates from each of specialist, high, medium and low tariff institutions.
- For each type of institution, each of the employment indicators for a single STEM discipline was compared with the equivalent indicator for STEM in its totality.
- For the purposes of this review, the STEM discipline was considered to have a 'high' employment indicator for a given institution type if it was more than 20% higher than the STEM totality indicator for that institution type.
- Where one or more of the three employment indicators for a STEM discipline were found to be 'high' that subject was flagged for further investigation.

4.18 Annex I provides details of all of the employment indicators calculated for these comparisons, and the thresholds for determining whether these showed an employment indicator as being high, or above average.

4.19 Employment statistics based on outcomes reported in the six-month destinations data were compared with those based on the 40-month destinations data, to determine whether less positive outcomes seemed to persist into the longer term. Time series data was also considered to confirm that trends had persisted over a number of years rather than being the result of a one off return.

4.20 The review also developed an online survey of stakeholders to gather more qualitative evidence on the employment outcomes for graduates, including some of the reasons for these outcomes.

4.21 The survey received 477 responses from HEIs, FECs, employers, PSRBs and students across a six-week period between June and July 2015. Responses were analysed by HEFCE and BIS colleagues. A more detailed analysis and summary of responses received is set out in Chapter 5, and the full list of survey questions is provided at Annex H.

[24] For example, the response of a single individual among a total of 10 graduates responding to destinations survey would have the ability to shift the overall statistic by 10 percentage points in either direction.

STAGE 2 – Identifying a list of STEM disciplines where there appeared to be grounds for concern around graduate employment outcomes

4.22 Stage 1 analysis presented two independent pictures of the employment outcomes of graduates from STEM disciplines across different parts of the English HE sector. The results of the destinations data analysis were examined alongside the findings of the stakeholder survey. Areas of coincidence and conflict between the two pictures were identified. In particular, the review categorised all STEM disciplines considered as part of the review, according to the level of concern around graduate employment outcomes. These categories are outlined below:

- Disciplines of concern which merit further investigation and a focus group – where the outcomes of destinations data analysis and stakeholder survey responses showed strong agreement around major concerns for employment outcomes
- Disciplines of concern which will be followed up by consultation with PSRBs and representative organisations via correspondence – where the outcomes of destinations data analysis and stakeholder survey responses showed some agreement around minor concerns for employment outcomes or where there was disagreement between the two pictures and a clear outcome could not be determined
- Disciplines that do not require further action as part of this review – where the outcomes of both destinations data analysis and stakeholder survey responses showed little cause for concern within the scope of this review and at this time

STAGE 3 – Focussed investigation of particular STEM disciplines, including running focus groups and consulting PSRBs and representative organisations

4.23 The third stage of evidence gathering aimed to investigate in more detail the reasons behind the employment outcomes of graduates from the two categories where data indicated cause for concern.

4.24 Three discipline-specific focus groups were held (further information is available at Annex E) to consider the employment outcomes for graduates from the following disciplines, where there was strong evidence to suggest a cause for concern:

- Biological Sciences
- Earth, Marine and Environmental Sciences (EMES)
- Agriculture, Food Sciences and Animal Sciences (excluding Forestry)

4.25 The review also consulted with 24 PSRBs and representative organisations inviting their input on the STEM disciplines within the second category of concern – where there was some indication of cause for concern.

Additional evidence gathering and advice

4.26 The review has also drawn on a large amount of secondary evidence, including reports from the HE sector, Government, employers and professional and representative bodies. A list of references is provided at the end of this report.

4.27 The review lead and team were supported by an Advisory Group which met five times between 13 April 2015 and 12 January 2016. Terms of Reference for the review and the Advisory Group Membership are available at Annexes A and B. The membership of the Group was drawn from relevant professional bodies/representative groups, industry and the HE sector. The aims of the Group were to:

- provide advice and guidance to the Review Lead as the review developed, including endorsement of the data analysis approach and categorisation of in scope disciplines
- comment on emerging findings of analysis, including advising where additional data might be required and/or available
- provide a mechanism for gathering the input of a range of key stakeholders
- provide suggestions on those stakeholders with which the reviews ought to engage as the evidence gathering became more targeted.

5 What the data tells us

5.1 Table 1 below shows how many students started undergraduate degree programmes in 2014-15 in the STEM disciplines that are within the scope of this review.

Table 1 Numbers of entrants in 2014-15 by broad STEM subject area. HEFCE analysis of the HESA standard registration population at publicly-funded English HEIs.

Course category	Numbers of 2014-15 undergraduate entrants	Of which, first degree entrants	Of which, full-time first degree entrants
Agriculture and Forestry	6,065	2,730	2,670
Anatomy, Physiology and Pathology	3,950	3,870	3,780
Biological Sciences (overall)	18,380	17,140	16,470
Chemistry and Materials Science	5,315	5,135	5,075
Computer Sciences (overall)	22,985	21,215	18,840
Earth, Marine and Environmental Sciences	4,230	3,885	3,135
Chemical, Process and Energy Engineering	2,440	2,360	2,355
Civil Engineering	3,980	3,545	3,260
Electronic and Electrical Engineering	6,410	5,375	5,145
General Engineering	5,990	4,640	3,310
Mechanical, Aero and Production engineering	11,610	10,180	9,755
Minerals, Metallurgy and Materials Engineering	855	680	670
Others in Engineering and Technology	3,195	2,065	1,910
Mathematical Sciences	10,215	9,860	8,685
Pharmacology, Toxicology and Pharmacy	4,020	3,815	3,815
Physics and Astronomy	4,830	4,475	4,260
'High value' STEM disciplines total	114,480	100,960	93,125

5.2 Table 1 shows that there were just over 21,000 undergraduate entrants in 2014-15 who fall outside of the population for whom we are examining employment outcomes. Of these, 13,500 were studying undergraduate qualifications other than a first degree (either full- or part-time). The remaining 8,000 were studying part-time for a first degree qualification. Employment outcomes of part-time students are difficult to interpret because we know that high proportions are in employment at the same time as studying HE part-time: in terms of the destinations reported six months after leaving HE, we do

not know whether this destination is simply the one that they experienced throughout their studies (i.e. employment), or an enhanced version of that (i.e. pay rise, promotion or career change). Since it is not possible to attribute the outcome to HE (or not), we make no consideration here of these graduates. Similarly, we know that some other undergraduate qualifications can be 'topped-up' to a first degree. Our subsequent analysis of employment outcomes further restricts the population considered to UK-domiciled graduates only. HEIs are expected to meet, or exceed, a target response rate for DLHE of 80% for UK-domiciled HE leavers who previously studied full-time – which goes some way to ensure that statistics derived from DLHE data are genuinely representative of the outcomes of students leaving HE.

Outcomes of Stage 1 – Initial data analysis (DLHE and LDLHE) survey

Analysis of DLHE and LDLHE data

5.3 The interrogation of destinations data for graduates from the STEM subjects listed in Table 1 showed some interesting results and differences in the employment outcomes of graduates both across subjects and across different types of HEIs.

5.4 Subject level data from the DLHE and LDLHE surveys were considered according to the following three indicators – unemployment level, graduates in non-graduate roles and graduates on low salaries – and according to the three groupings of HEIs based on their average UCAS tariff for young undergraduate entrants – high, medium and low tariff. The results of this analysis are provided in Table 2.

Table 2 Analysis of key employment statistics for different STEM disciplines.

Broad subject area	Unemployment level	Graduates in non-graduate roles	Graduates on low salaries
Agriculture, Forestry, Animal Science and Food Science	Generally low average unemployment. Slightly higher unemployment for high tariff institutions.	High proportion in non-graduate roles, from all institution types.	High proportion in low-pay roles, from all institution types in 2013-14 (above average for specialist institutions in 2011-12 and 2012-13).
Anatomy, Physiology and Pathology	Generally low average unemployment. Slightly higher unemployment for high tariff institutions.	High proportion in non-graduate roles from high tariff institutions	High proportion in low-pay roles for high tariff institutions. Low proportions for other institution types.
Biological Sciences	Above average unemployment for high tariff institutions. Below average for low tariff institutions.	High proportions in non-graduate roles for all institution types	High proportion in low-pay roles.
Chemistry and Materials Science	Above average unemployment rates in 2013-14 (below average for low tariff institutions in 2011-12 and 2012-13).	Above average proportion in non-graduate roles across all institution types.	Above average proportion in low-pay roles from all institution types (high proportions for medium average tariff institutions).
Earth, Marine and Environmental Sciences	Above average unemployment at high and medium tariff institutions, lower unemployment for low tariff institutions.	High proportion in non-graduate roles.	High proportion in low-pay roles.
Overall Engineering and Technology	Below average unemployment in 2012-13 and 2013-14, above average unemployment rates in 2011-12.	Below average proportions in non-graduate, and low proportions for high tariff institutions.	Low proportions in non-graduate roles.
Chemical, Process and Energy Engineering	High unemployment especially for high tariff institutions.	Low proportion in non-graduate roles (except low tariff institutions in 2013-14).	Low proportions in low-pay roles.
Civil Engineering	Low unemployment rates, slightly higher at high tariff institutions.	Low proportions in non-graduate roles.	Low proportion in low-pay roles.
Electronic and Electrical Engineering	Above average unemployment.	Below average proportions in non-graduate roles at low and medium tariff institutions, low proportions at high tariff institutions.	Low proportions in low-pay roles from high tariff institutions, below average for medium tariff institutions and variability for low tariff institutions (below average in 2013-14, above average in 2012-13).
General Engineering	Below average unemployment overall, above average unemployment for high tariff institutions in 2012-13 and 2013-14	Low proportions in non-graduate roles.	Low proportions in low-pay roles.

Table 2 Continued

Broad subject area	Unemployment level	Graduates in non-graduate roles	Graduates on low salaries
Mechanical, Aero and Production Engineering	Below average unemployment rates overall: below average for low tariff institutions and variability for high and medium tariff institutions across 2011-12 to 2013-14.	Low proportions in non-graduate roles, except for medium tariff institutions and for high tariff institutions in 2011-12, where proportions are below average.	Low proportion in low-pay roles.
Minerals, Metallurgy and Materials Engineering	Low unemployment rates except for high tariff institutions where it is above average.	Above average proportion in non-graduate roles, high proportions from low tariff institutions.	High proportion in low-pay roles for all institution types.
Others in Engineering and Technology	Variability in unemployment rates: below average in 2012-13, above average in 2011-12 and 2013-14.	High proportions at low tariff institutions and low proportions at high tariff institutions.	High proportions at low tariff institutions and low proportions at high tariff institutions.
Mathematical Sciences	Below average unemployment.	Above average proportion in non-graduate roles for high tariff institutions, high proportions for medium tariff institutions.	Above average in low-pay roles for high tariff institutions.
Pharmacology, Toxicology and Pharmacy	Low unemployment rates.	Low proportions in non-graduate roles for all institution types.	High proportion in low-pay roles.
Physics and Astronomy	Above average unemployment, especially for medium tariff institutions	Below average proportion in non-graduate roles overall but variability across institution types and 2011-12 to 2013-14.	Below average proportions in low-pay roles.

Note: Cells highlighted in light shading indicate above average statistics, those highlighted in dark shading indicate high proportion or high unemployment rate. The table provides an analysis of three employment indicators across three cohorts of graduates from 2011-12, 2012-13 and 2013-14. Where applicable, any variations between years are included within the commentary.

5.5 In addition, where there was no cause for concern at the broad subject level, or where the review required further assurance, the data was disaggregated and examined at detailed subject level to see if there were any issues which had been masked by aggregating the data. Where disciplines displayed significant differences from the outcomes at the broad subject level, they are presented in Table 3.

Table 3 Analysis of key employment statistics for specific courses.

Broad subject area	Detailed subject area	Unemployment level	Graduates in non-graduate roles	Graduates on low salaries
Biological Sciences	F400 - Forensic and Archaeological Science	Above average unemployment rates overall and for high tariff institutions, below average unemployment for medium and low tariff institutions.	High proportion in non-graduate roles for all institution types.	High proportion earning low salaries for all institution types.
General Engineering	H150 - Engineering Design	Variability in unemployment rates over time. High unemployment rates for medium tariff institutions in 2012-13, low rates in 2011-12 and 2013-14. High unemployment rates for high tariff institutions in 2011-12, low rates in 2012-13 and below average in 2013-14.	Low proportions in non-graduate roles.	Low proportions earning low salaries overall in 2011-12 and 2013-14 (and below average in 2012-13).
General Engineering	H160 - Bioengineering, Biomedical Engineering and Clinical Engineering	High unemployment rates for medium tariff institutions in 2012-13, below average in 2013-14.	No data.	No data.
Mechanical, Aero and Production Engineering	H400 - Aerospace Engineering	Variability over time in unemployment rates: above average unemployment rates for high tariff institutions, high unemployment for medium tariff institutions in 2011-12 and 2012-13 and above average in 2013-14.	High proportion in non-graduate roles from medium tariff institutions in 2012-13 and above average in 2013-14. Other institution types have below average proportions in non-graduate roles.	Low proportions earning low salaries for all institution types.
Electronic and Electrical Engineering	H640 - Communications Engineering	Above average unemployment rates.	Generally below average proportion in non-graduate roles, but high for low tariff institutions.	High proportion earning low salaries from medium and low tariff institutions.
Electronic and Electrical Engineering	H650 - Systems Engineering	High unemployment rates in 2012-13 and above average in 2011-12. Low unemployment rates in 2013-14, aside from medium tariff institutions where it is above average.	Low proportions in non-graduate roles overall.	Low proportions earning low salaries in 2013-14. No data for previous years for comparison.
Mechanical, Aero and Production Engineering	H700 - Production & Manufacturing Engineering	Above average unemployment rates for medium tariff institutions in 2011-12 and 2012-13, high unemployment in 2013-14.	High proportion in non-graduate roles from medium tariff institutions in 2011-12 and 2013-14 (and above average in 2012-13).	Generally low proportions earning low salaries. Above average proportion for medium tariff institutions in 2011-12 and 2013-14.
Minerals, Metallurgy and Materials Engineering	J400 - Polymers & Textiles	Low unemployment rates.	High proportions in non-graduate roles for all institution types.	High proportions on low salaries for all institution types.

Note: Cells highlighted in light shading indicate above average statistics, those highlighted in dark shading indicate a high proportion or high unemployment rate. The table provides an analysis of three employment indicators across three cohorts of graduates from 2011-12, 2012-13 and 2013-14. Where applicable, any variations between years are included within the commentary.

5.6 The data interrogation at both a broad and detailed subject level allowed the review to consider which STEM disciplines would not be subject to closer examination. This consideration also reflected both the remit of the review and the resources available. The review also assessed the numbers of students studying particular subjects and therefore whether their impact was significant enough for inclusion within the remaining stages of the review.

5.7 The subjects therefore excluded from further consideration at this stage were:

- Anatomy, Physiology and Pathology – small direct impact on the economy
- Forensics – no direct impact on the economy
- Forestry – small student numbers with 110 undergraduate entrants in each of the academic years 2012-13 to 2014-15, of which 30 were commencing a full-time first degree course.
- Minerals, Metallurgy and Materials Engineering, including Polymers and Textiles – relatively small student numbers, including small cohorts studying Polymers and Textiles (in 2013-14, there were 155 UK-domiciled qualifiers from full-time first degree study at publicly-funded English HEIs who provided a valid response to the DLHE), which is a very specialised discipline.
- Production and Manufacturing Engineering – student numbers in this relatively specialised subject are small with much of this activity now offered as part of wider degree programmes. In 2013-14, there were 310 UK-domiciled graduates from full-time first degree study at publicly-funded English HEIs who provided a valid response to the DLHE in relation to this subject.
- Others in Engineering – this is a miscellaneous grouping for related subjects which do not fit into the other engineering and technology categories examined. It includes naval architecture and maritime technology as well as engineering subjects not elsewhere classified and which HEIs are directed to use sparingly when returning data to the funding councils and HESA.

5.8 The following subject group at the broad **and** detailed subject level were excluded from further consideration on the basis that their employment outcomes did not give cause for concern:

- Civil Engineering

5.9 The outcomes of the destinations analysis showed significant cause for concern for a number of subjects, including:

- Biological Sciences
- Earth, Marine and Environmental Sciences
- Agriculture, Food Sciences and Animal Sciences (excluding Forestry)

5.10 Destinations data for these three disciplines is provided in Table 4.

Table 4 Employment outcomes of UK-domiciled full-time first degree graduates from Biological Sciences, EMES, Agriculture, Animal Sciences and Food Sciences, all STEM and all HE subjects

	Biological Sciences (not including Forensic and Archaeological Sciences)	Earth, Marine and Environmental Sciences	Agriculture, Animal Science and Food Science (not including Forestry)	STEM average (including Agriculture and Forestry)	STEM average (not including Agriculture and Forestry)	All HE subjects
Unemployment rate (2013-14 graduates 6 months after leaving HE)	8.4%	8.5%	6.7%	8.3%	8.4%	6.6%
Proportion of graduates in non-graduate roles (6 months)	43.1%	38.7%	50.1%	25.1%	24.0%	32.1%
Proportion of graduates earning low salaries (6 months)	59.4%	51.1%	62.3%	36.0%	35.0%	45.1%
Unemployment rate (2010-11 graduates 40 months after leaving HE)	3.3%	3.9%	2.5%	3.2%	3.2%	2.9%
Proportion of graduates in non-graduate roles (40 months)	19.5%	19.1%	45.0%	16.2%	14.7%	23.2%
Proportion of graduates earning low salaries (40 months)	30.0%	32.0%	44.2%	19.0%	17.9%	26.0%

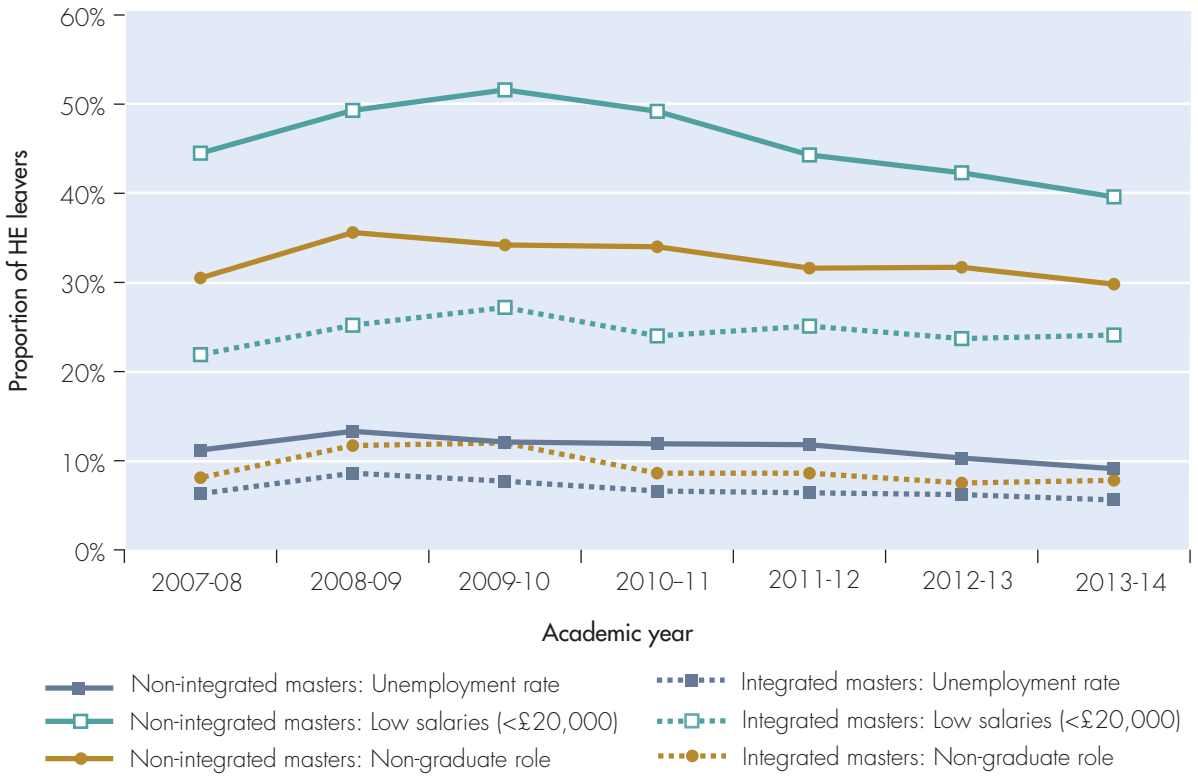
Note: Equivalent information for the 2012-13 (DLHE) and 2008-09 (LDLHE) cohorts – the most recent available at the commencement of this review, and used as the basis for early analysis – is provided at Annex G. Non-graduate jobs are those which are not classified as 'Professional or managerial roles' on the basis of SOC 2010 major groupings.

HEFCE analysis of the HESA standard qualifiers populations 2010-11 and 2013-14, the Destination of Leavers from Higher Education survey 2013-14 and Longitudinal Destination of Leavers from Higher Education survey 2010-11. UK-domiciled qualifiers from full-time first degree qualifications registered at publicly-funded English HEIs only. Graduates who provided a valid response to the relevant destinations survey. All percentages based on fewer than 22.5 qualifiers are not considered to be statistically robust and are suppressed and included under a grouping labelled 'Too small'.

5.11 The analysis also revealed two interesting and more general facts about STEM graduates on different kinds of first degree courses:

- As Figure 6 demonstrates, students who undertake an integrated Masters degree programme have better employment outcomes than those on Bachelors (traditionally three-year full-time) degree programmes

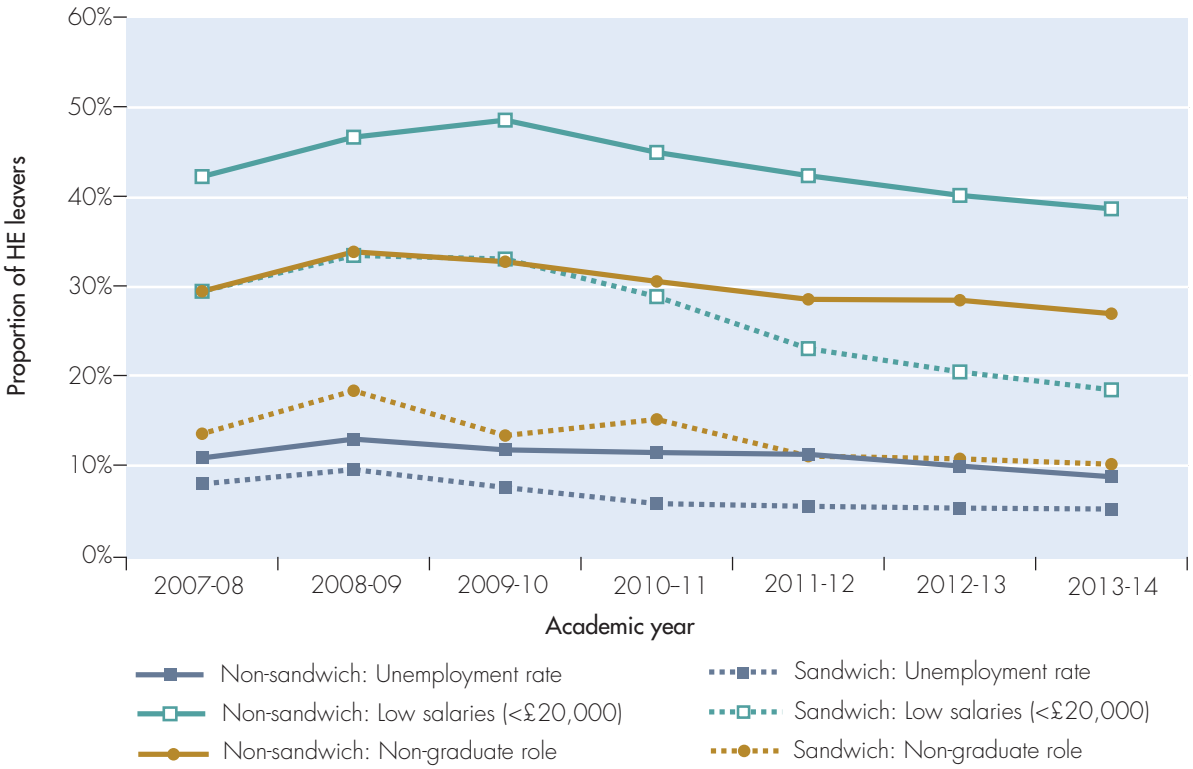
Figure 6 Employment outcomes of UK-domiciled full-time first degree graduates from STEM subjects (including Agriculture and Forestry) six months after leaving HE: graduates from publicly-funded English HEIs by employment measure and course type, 2007-08 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2007-08 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

- As Figure 7 shows, students who have undertaken a sandwich year programme (traditionally taken as the third year working in industry before returning in the fourth year to complete their studies) have better employment outcomes than those who did not take a sandwich year programme.

Figure 7 Employment outcomes of UK-domiciled full-time first degree graduates from STEM subjects (including Agriculture and Forestry) six months after leaving HE: graduates from publicly-funded English HEIs by employment measure and sandwich course, 2007-08 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2007-08 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

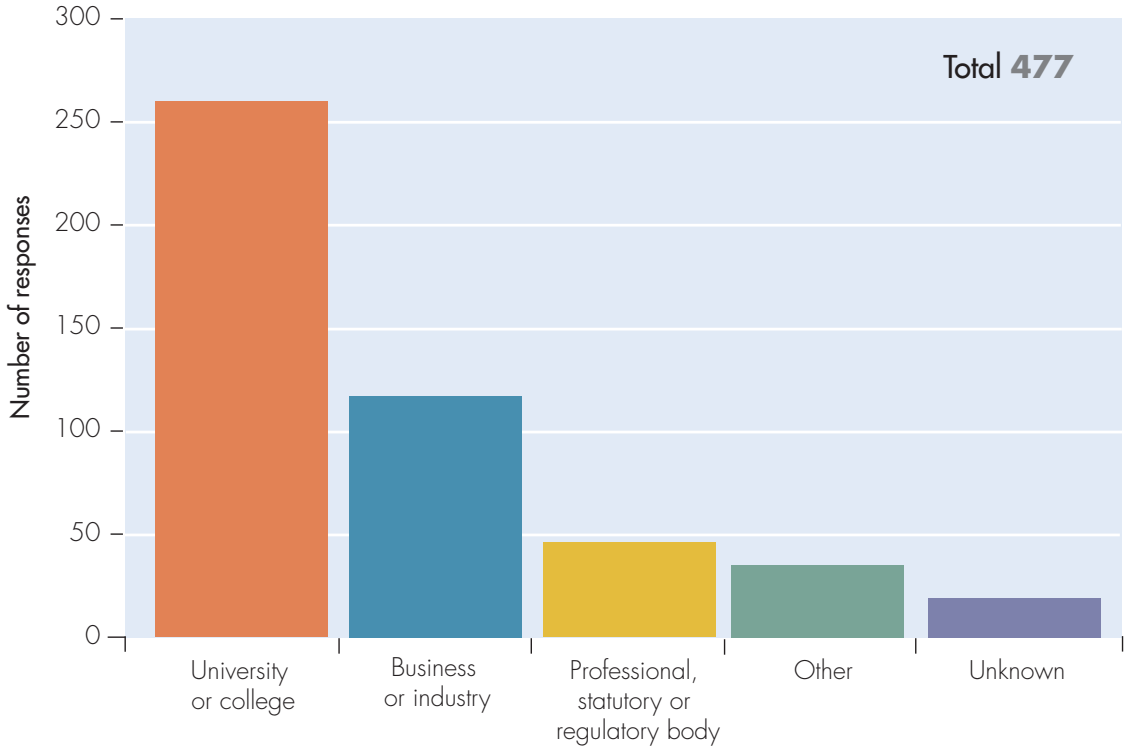
Stakeholder survey

5.12 To provide further context to our understanding of the employment outcomes of STEM graduates and to enable a test of the outcomes of destinations data analysis, the review developed and published an online survey inviting views from a wide range of individuals and organisations, including HEIs, FECs, PSRBs, representative organisations, employers and students.

5.13 The survey received 477 responses across a six-week period between June and July 2015. The survey questions and key messages arising from the responses to the stakeholder survey are summarised below. The full text of the the survey questions is provided at Annex H.

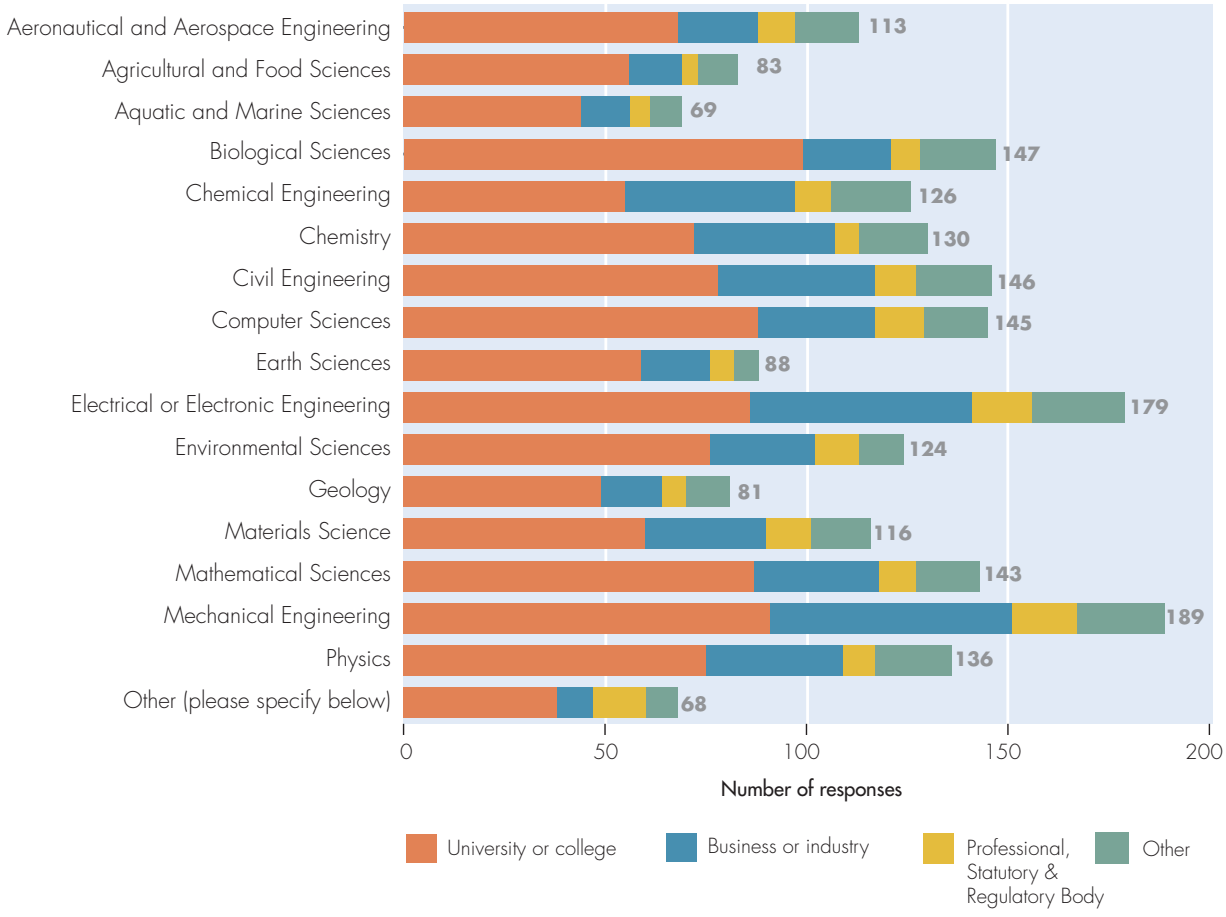
5.14 Figure 8 shows the responses to the survey by type of stakeholder. There was a good response from the three key stakeholders – universities/colleges (referred to collectively as HE providers), Business/industry and PSRBs, although the large majority of responses were from HE providers.

Figure 8 **Responses to survey by stakeholder type**



5.15 Figure 9 provides a further breakdown of responses by organisation type and by discipline. Again, this shows a spread of responses across the disciplines considered as part of the review.

Figure 9 **Responses to survey by discipline**



5.16 All respondents were invited to answer general questions, followed by a series of specific questions, including a set of particular questions which reflected the organisation type they were representing. This enabled an analysis of the particular issues for HE providers, industry and PSRBs.

5.17 Respondents also indicated the extent to which they felt graduates were meeting the needs of employers in a range of disciplines. The responses to the survey pointed to a potential concern around the employability of graduates in a number of disciplines. For example, there were 11 disciplines where 35% or more responses indicated they strongly disagreed, disagreed or neither agreed nor disagreed that graduates met the needs of employers. In discussions with the Advisory Group, it was felt that this level of dissatisfaction represented a cause of concern. The 11 disciplines are listed below:

- Agricultural and Food Science
- Aquatic and Marine Science
- Biological Sciences
- Chemistry
- Computer Sciences
- Earth Sciences
- Environmental Sciences
- Geology
- Materials Science
- Mathematical Sciences
- Physics

5.18 All stakeholders were invited to identify up to three main issues that they thought impacted on graduate employability across all STEM disciplines and to provide evidence to support their claims. The most common issues identified across all types of respondents were:

- **Graduates are lacking 'softer' skills and business/commercial awareness.** In response to specific questions to business and industry about work readiness skills, business awareness and practical subject-specific skills, respondents felt strongly that graduates were lacking in these areas. A lack of ability to adapt learning from their degree programmes and to put their theoretical knowledge to practical use were also common themes.
- **Graduates are lacking work experience.** When specifically asked about student placements and work experience, there was a large degree of agreement amongst stakeholders that almost any such activity enhanced graduate employability.
- **Graduates are not sufficiently engaged in career planning.** Graduates were often unaware of the opportunities available to them and failed to engage early enough in career planning. This was despite respondents from PSRBs indicating that they felt there were well-defined industries within which STEM graduates might find employment and that STEM graduates were able to find work in a wide range of businesses and industries.

- **Graduates are lacking in quantitative skills and mathematics.** A high proportion of respondents who identified this as being a potential problem were from HE providers. This aligns with a recent British Academy report on the demand for quantitative skills to support the UK economy and society[25].

5.19 The survey highlighted strong agreement among all stakeholders that student placements in business or industry enhance employability. Linked to this, there was also strong agreement that the engagement of HE providers with industry led to enhanced employability of students and graduates. Business and industry and PSRBs were less convinced than HE providers about the impact on employability of where and what a student had studied – including the reputation of the institution and the curriculum studied.

5.20 HE providers were asked a number of questions related to employability. Responses strongly indicated that there was further capacity to include employability topics in curricula. In response to specific questions on assurance processes in place within their institution, HE providers indicated that, of a range of systems and processes, including external examiners and external benchmark statements, it was professional accreditation systems that had the highest impact on graduate employability.

5.21 Business and industry were also asked a set of specific questions related to graduate employability. In response to a series of statements about the skills and knowledge of graduates, responses from business and industry showed a modest level of dissatisfaction with the skills of graduates, so that:

i. Only 25% agreed that graduates have the required 'work ready' skills or business awareness,

ii. Only 33% agreed that graduates have all the practical subject specific skills required

On the other hand:

iii. 60% agreed that graduates have all the subject knowledge required

iv. 80% agreed that graduates have necessary experience of modern scientific equipment

5.22 All respondents from business and industry either agreed or strongly agreed that industrial experience of graduates (for instance sandwich placements, other placements, general work experience) led to enhanced employability. However, only 45% of business or industry respondents indicated that their organisation was strongly engaged with HE delivery, with 45% saying they could be more engaged and 9% saying they had no formal engagement.

5.23 In response to the specific questions posed to PSRBs, 79% either strongly agreed or agreed that graduates are able to find employment in a wide range of businesses and industries. Of the 24 responses from PSRBs, 58% stated that they do require business and industry involvement in the degree programme as a condition for accreditation, with

25 http://www.britac.ac.uk/policy/count_us_in_report.cfm

the remainder (42%) not requiring involvement. The majority of these accreditation processes include a visit to the university or college (83% always include this, 12% sometimes include this) and of those that do include a visit, 59% of these visits always include a representative from business and industry with 36% sometimes including a business representative. Accreditation might therefore be reasonably viewed as an engagement channel for HE and industry.

Outcomes of Stage 2 – list of disciplines of 'concern'

5.24 The outcomes of the independent quantitative and qualitative data analysis in Stage 1 presented some interesting correlations. The disciplines highlighted through the interrogation of destinations data were very similar to those highlighted through the stakeholder survey. Based on this evidence, the review then categorised all STEM disciplines considered as part of the review, according to the level of concern around graduate employment outcomes. These categories are outlined below:

Disciplines of concern which are judged to merit further investigation and a focus group – where the outcomes of destinations data analysis and stakeholder survey responses showed a strong agreement around concerns for employment outcomes

Disciplines of concern which are judged to merit further investigation through follow up correspondence with PSRBs and representative organisations – where the outcomes of destinations data analysis and stakeholder survey responses showed some, but not overwhelming agreement around concerns for employment outcomes or where there was disagreement

Disciplines that are judged to require no further action as part of this review – where the outcomes of destinations data analysis and stakeholder survey responses showed little cause for concern

5.25 Table 5 provides an overview of the findings of the review for those disciplines where there was cause for concern and the action agreed for stage 3 of evidence gathering for the review.

Table 5 – Findings for disciplines where evidence gathering indicated a cause for concern and the agreed action for each broad subject area or detailed subject area.

Broad subject area	Detailed subject area (where applicable)	Unemployment level	Graduates in non-graduate roles	Graduates on low salaries	Action
Agriculture, Forestry, Animal Science and Food Science		Generally low average unemployment. Slightly higher unemployment for high tariff institutions.	High proportion in non-graduate roles, from all institution types.	High proportion in low-pay roles, from all institution types in 2013-14 (above average for specialist institutions in 2011-12 and 2012-13).	Focus group.
Biological Sciences		Above average unemployment for high tariff institutions. Below average for low tariff institutions.	High proportions in non-graduate roles for all institution types.	High proportion in low-pay roles.	Focus group.
Chemistry and Materials Science		Above average unemployment rates in 2013-14 (below average for low tariff institutions in 2011-12 and 2012-13).	Above average proportion in non-graduate roles across all institution types.	Above average proportion in low-pay roles from all institution types (high proportions for medium average tariff institutions).	Correspondence with PSRB/ representative bodies.
Earth, Marine and Environmental Sciences		Above average unemployment at high and medium tariff institutions, lower unemployment for low tariff institutions.	High proportion in non-graduate roles.	High proportion in low-pay roles.	Focus group.
Chemical, Process and Energy Engineering		High unemployment especially for high tariff institutions.	Low proportion in non-graduate roles (except low tariff institutions in 2013-14).	Low proportions in low-pay roles.	Correspondence with PSRB/ representative bodies.
Mathematical Sciences		Below average unemployment.	Above average proportion in non-graduate roles for high tariff institutions, high proportions for medium tariff institutions.	Above average in low-pay roles for high tariff institutions.	Correspondence with PSRB/ representative bodies.
Pharmacology, Toxicology and Pharmacy		Low unemployment rates.	Low proportions in non-graduate roles for all institution types.	High proportions in low-pay roles.	Correspondence with PSRB/ representative bodies.

Broad subject area	Detailed subject area (where applicable)	Unemployment level	Graduates in non-graduate roles	Graduates on low salaries	Action
Physics and Astronomy		Above average unemployment, especially for medium tariff institutions.	Below average proportion in non-graduate roles overall but variability across institution types and 2011-12 to 2013-14.	Below average proportions in low-pay roles.	Correspondence with PSRB/ representative bodies.
General Engineering	H150 - Engineering Design	Variability in unemployment rates over time. High unemployment rates for medium tariff institutions in 2012-13, low rates in 2011-12 and 2013-14. High unemployment rates for high tariff institutions in 2011-12, low rates in 2012-13 and below average in 2013-14.	Low proportions in non-graduate roles.	Low proportions earning low salaries overall in 2011-12 and 2013-14 (and below average in 2012-13).	Correspondence with PSRB/ representative bodies.
General Engineering	H160 - Bioengineering, Biomedical Engineering and Clinical Engineering	High unemployment rates for medium tariff institutions in 2012-13, below average in 2013-14.	No data.	No data.	Correspondence with PSRB/ representative bodies.
Mechanical, Aero and Production Engineering	H400 - Aerospace Engineering	Variability over time in unemployment rates: above average unemployment rates for high tariff institutions, high unemployment for medium tariff institutions in 2011-12 and 2012-13 and above average in 2013-14.	High proportion in non-graduate roles from medium tariff institutions in 2012-13 and above average in 2013-14. Other institution types have below average proportions in non-graduate roles.	Low proportions earning low salaries for all institution types.	Correspondence with PSRB/ representative bodies.
Electronic and Electrical Engineering	H640 - Communications Engineering	Above average unemployment rates.	Generally below average proportion in non-graduate roles, but high for low tariff institutions.	High proportion earning low salaries from medium and low tariff institutions.	Correspondence with PSRB/ representative bodies.
Electronic and Electrical Engineering	H650 - Systems Engineering	High unemployment rates in 2012-13 and above average in 2011-12. Low unemployment rates in 2013-14, aside from medium tariff institutions where it is above average.	Low proportions in non-graduate roles overall.	Low proportions earning low salaries in 2013-14. No data for previous years for comparison.	Correspondence with PSRB/ representative bodies.

Outcomes of Stage 3 – discipline-specific evidence gathering

5.26 The third stage of evidence gathering for the review sought to test in further detail whether the outcomes of analysis at the first two stages had presented an accurate picture of the employment outcomes landscape for these particular disciplines. It sought to understand possible reasons for employment problems in particular disciplines to lend support to the identification of the existence of a problem. This stage also aimed to identify additional information that could help to develop our understanding of the issues for the graduates in question. The outcomes of stage 3 were then used to develop specific recommendations which identified STEM disciplines for future investigation.

5.27 To address appropriately these issues, we ran focus groups for the three disciplines where evidence had presented the greatest cause for concern. For those disciplines that had been identified as being of lower level concern, we invited relevant representative organisations drawn from PSRBs, employers and industrial representative groups to contribute their views on the accumulated body of evidence.

5.28 Over 40 organisations, including HE providers, current students, employers and professional bodies, attended the focus groups to help to test the outcomes of the initial evidence gathered that pointed to a potential problem with employment outcomes. Annex E provides a background to the focus groups, including the attendees and organisations that were represented. The focus groups sought to explore in more detail the potential reasons for each discipline's poor employment outcomes. The groups were also challenged to come to a view on whether the discipline in question warranted further investigation through future, targeted work. Discussion was not intended to come to definitive conclusions about solutions to identified problems with graduate employment outcomes for the individual discipline in question, but to investigate in further detail why evidence was pointing to employment difficulties for some graduates.

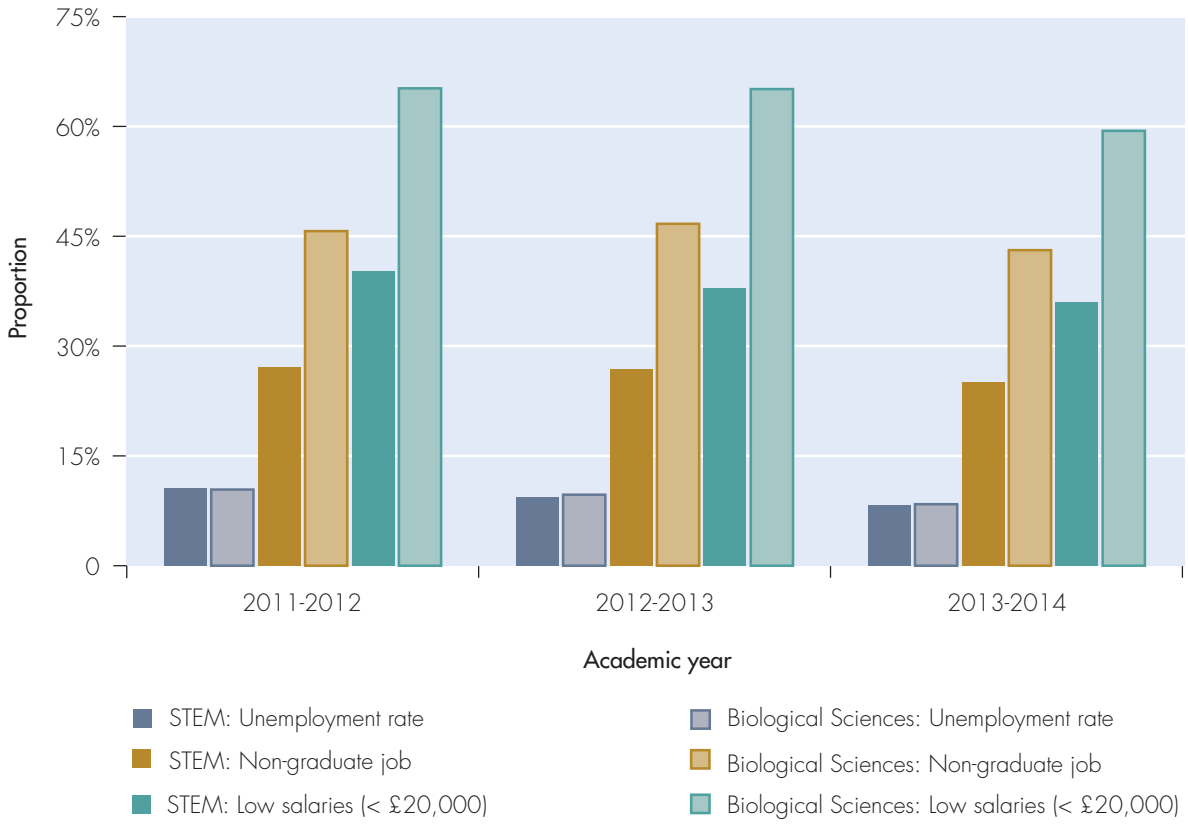
Biological Sciences

Background

5.29 The Biological Sciences group of disciplines includes degree programmes within the subjects listed in paragraph 4.10. In 2014-15, there were 16,470 entrants to full-time first degree study in Biological Sciences programmes at publicly-funded English HEIs, with the majority of those on Biology programmes (7,210 entrants). Of the total, 9,765 were women and 6,705 were men. The majority were young entrants (14,095 compared to 2,375 mature entrants) and, of these young entrants, 1,410 were from low participation neighbourhoods (LPNs). Biological Sciences provision is spread across a range of HEIs, with 7,195 entrants studying at HEIs with high average UCAS tariff scores, 5,555 at HEIs with medium average UCAS tariff scores and 3,670 at low average UCAS tariff HEIs. 14,635 of the Biological Sciences entrants were UK-domiciled, with another 810 domiciled in the EU and the remaining 1,025 from non-EU countries.

5.30 Figure 10 shows the employment outcomes for UK-domiciled full-time first degree graduates from Biological Sciences programmes at publicly-funded English HEIs six months after graduation, and compares these outcomes to the average for all STEM disciplines. The employment outcomes for graduates from this group show a very large number of graduates in non-graduate roles and a very high proportion of graduates are earning low salaries. While these figures decline 40 months after graduation, there are still high numbers of graduates in both non-graduate roles and earning low salaries.

Figure 10 Employment outcomes of UK-domiciled full-time first degree graduates from STEM (including Agriculture and Forestry) and Biological Sciences (NOT including Forensic and Archaeological Science) six months after leaving HE: graduates from publicly-funded English HEIs, 2011-12 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2011-12 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

Review findings

5.31 Biological Sciences-related responses to the stakeholder survey indicated that only half of respondents from business or industry thought that Biological Sciences graduates met the employability requirements of industry. The remaining 50% either strongly disagreed, disagreed or neither disagreed or agreed with this. In comparison, just over 70% of respondents from universities and colleges either agreed or strongly agreed that Biological Sciences graduates met the employability requirements of industry.

5.32 This potential mismatch between the views of HE providers and industry was highlighted in the focus group which suggested that any future work to consider the employment outcomes of Biological Sciences graduates might investigate the number of unfilled vacancies to assess demand. Overall, the review has found that Biological Sciences needs greater engagement between the HE sector and industry and that there needs to be a real commitment from employers to help steer Biological Sciences provision.

5.33 The stakeholder survey suggested that the following issues might be affecting employment outcomes for Biological Sciences graduates:

- Graduates lacking 'soft skills'
- Graduates lacking work experience
- Graduates lacking business or commercial awareness
- Graduates lacking mathematical skills.

5.34 While many of the broad findings from the stakeholder survey were common across all disciplines, graduates lacking mathematical skills was identified as being a specific problem for the employability of graduates from Biological Sciences. This finding was supported by discussions in the focus group, which suggested that future work into Biological Sciences might investigate the extent to which degree programmes include quantitative methods, and whether they prepare students to apply them to practical problems. Interestingly, weaknesses in mathematics skills were highlighted by ABPI in its recent report on skills gaps in the biopharmaceutical industries, *Bridging the skills gaps in the biopharmaceutical industry*[26], with specific concerns highlighted around 'bioinformatics, statistics, data mining, health informatics and health economics and outcomes.'

5.35 However, there was a strong view in the focus group that introducing A-Level Mathematics as an admissions requirement, or offering 'catch up modules', would not be effective. Instead the focus group felt more needed to be done to integrate applications of mathematics into courses. This may suggest a further disagreement between business and industry on the one hand and HE providers on the other about the flexibility and transferability of Biological Sciences graduates. It was suggested that there is an increasing emphasis on quantitative skills across many different types of industries and sectors, regardless of the STEM discipline in question. The importance of Biological Sciences graduates possessing good quality mathematical and quantitative skills which would enable them to access roles across a wide range of industries was emphasised. The need for individuals with quantitative skills is reiterated in the British Academy report, Count Us In[27].

5.36 The focus group also suggested that Biological Sciences graduates would benefit from spending more time on developing advanced practical skills at an earlier stage and developing transferrable skills, in particular teamwork.

5.37 Both the survey and focus group findings strongly indicate that work experience, through placements, improves a student's employment potential. However, for Biological Sciences, as with other disciplines, there may be an issue with an adequate supply of

26 http://www.abpi.org.uk/our-work/library/industry/Documents/Skills_Gap_Industry.pdf
27 http://www.britac.ac.uk/policy/count_us_in_report.cfm

quality placements. Much of the demand for Biological Sciences graduates comes from small and medium-sized enterprises (SMEs) who may lack the capacity to provide placements. The focus group emphasised the importance of ensuring the quality of placements for students, who also need more information about their value. Students should be prepared to take shared responsibility for researching and seeking out opportunities for work experience.

5.38 A common theme across the review, which was reiterated in the focus group held to discuss Biological Sciences, was the need to provide students with subject-specific careers advice throughout their degree programme and not only in their final year. For those students with the skills and potential, the Biological Sciences jobs market is diverse. However this diversity can mean that career opportunities and pathways are not always clear for students and graduates.

5.39 The focus group highlighted that accreditation of Biological Sciences degree programmes has recently been developed and introduced by the Royal Society of Biology. An assessment of the impact of these processes is therefore not yet practicable. However, the review's findings indicate that accreditation of Biological Sciences programmes may play a useful future role in:

- examining the mathematical/quantitative skills (and possibly also computer-programming) content of biological sciences programmes
- accrediting the skills gained during work experience, which may contribute to a student's professional registration, such as a Registered Scientist and Chartered Scientist
- facilitating engagement between HE providers and business/industry.

5.40 In response to the review team's presentation of the findings related to Biological Sciences, the focus group held to discuss Biological Sciences employment outcomes agreed that this broad discipline area required exploration through future work. The review believes that a more intensive interrogation of the data at the detailed discipline level would more adequately consider the large number of sub-disciplines that comprise this group.

Earth, Marine and Environmental Sciences

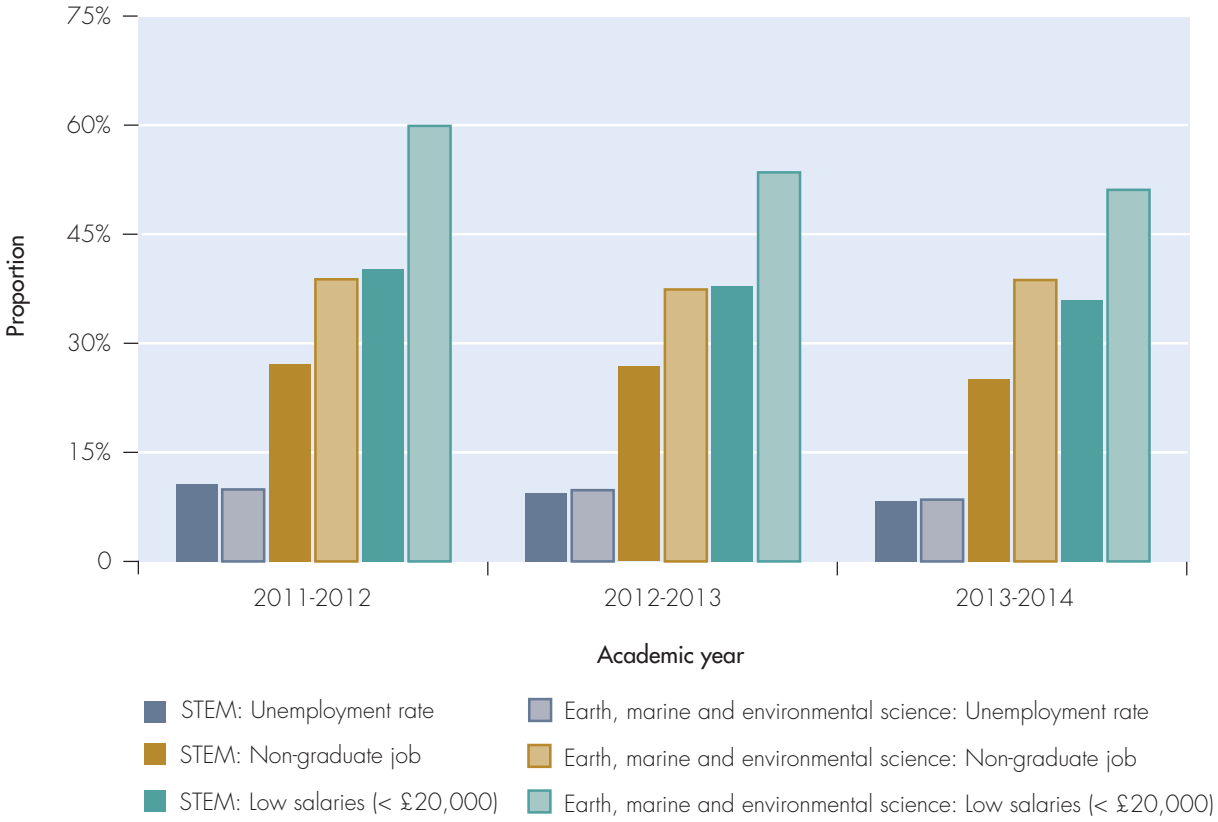
Background

5.41 Earth, Marine and Environmental Sciences incorporates the subject areas of Geology (which includes the sub disciplines of Geophysics, Geochemistry and Hydrogeology, among others); Sciences of Aquatic and Terrestrial Environments (which itself incorporates sub disciplines including Marine, Ocean, Environmental and Soil Sciences, as well as Climatology); and Physical Geographical Sciences (including Environmental and Physical Geography, Cartography and Geomorphology, among others).

5.42 Its student population is far smaller than Biological Sciences with 3,135 full time first degree entrants at publicly-funded English HEIs in 2014-15. 1,230 entrants are female, compared to 1,905 men. 2,705 are young entrants, compared to 430 mature students and, of these young entrants, 180 are from a low participation neighbourhood (LPN). There were 2,705 UK-domiciled entrants, 85 EU domiciled and 345 non-EU domiciled. Of the UK-domiciled entrants, 285 were black and minority ethnic (BME).

5.43 Figure 11 shows the employment outcomes for UK-domiciled full-time first degree EMES graduates from publicly-funded English HEIs six months after graduation, compared to the average for all STEM disciplines. This indicates that six months after graduation, EMES graduates have very high levels of graduates in non-graduate roles and very high levels of graduates earning low salaries. The LDLHE survey collects further information on a sample of respondents to the DLHE three and a half years or 40 months after graduation. The 2008-09 and 2010-11 LDLHE data for EMES indicates that these issues persist although they are slightly reduced.

Figure 11 Employment outcomes of UK-domiciled full-time first degree graduates from STEM (including Agriculture and Forestry) and Earth, Marine and Environmental Sciences six months after leaving HE: graduates from publicly-funded English HEIs, 2011-12 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2011-12 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

Review findings

5.44 Responses to the stakeholder survey from EMES-related respondents were disaggregated according to: Aquatic and Marine Sciences, Environmental Sciences and Geology. However the number of responses by stakeholder group is too small to provide statistically meaningful analysis by sub-discipline and by stakeholder. Overall, however, there was variation in how well different stakeholders thought graduates from each of these groups were meeting employability requirements of employers.

5.45 The stakeholder survey outcomes support the views of focus group attendees that this group contains both a diverse range of disciplines but also diversity within disciplines, which lead to differential employment outcomes. For example, graduates from Environmental Sciences programmes may study a programme that is either science- or policy-rich in content and this will result in different career paths and employment in different industries. Any future work to consider this subject group in more detail would benefit from greater disaggregation of data and disciplines. Reflecting this diversity, salary levels as an indicator of employment outcomes may be misleading for some disciplines, particularly those connected to the environment, where students may undertake voluntary roles, often abroad, before returning to paid work or further study.

5.46 The review findings related to employment outcomes of EMES graduates also highlighted the range of employers where graduates will seek employment – from large multinationals, such as the oil industry, to SMEs, student start-ups to consultancies and charities. The diverse needs of such a range of employers and their expectations of graduates must pose some complication for students in exploring career options and for the design of courses that might have similar names but very different content and objectives.

5.47 Responses to the stakeholder survey suggested that the following issues might be affecting employment outcomes for EMES graduates:

- Graduates lacking 'soft skills'
- Graduates lacking business or commercial awareness
- Graduates lacking work experience
- Graduates lacking mathematical skills
- Graduates struggling to translate theoretical knowledge into practice
- Lack of graduate engagement in career planning.

5.48 This list of highlighted issues matches those identified for Biological Sciences respondents but includes two additional issues – graduates struggling to translate theoretical knowledge into practice and lack of graduate engagement in career planning. The review has found a number of issues specific to EMES in relation to the second issue of careers planning, advice and guidance, including those highlighted at the focus group:

- The nature of disciplines within the EMES subject group means that students are unlikely to have direct contact with their degree subject before they start their degree programme, and are therefore less exposed to the subject and career options.
- Information, advice and guidance on pathways to careers in these disciplines is also lacking within schools and colleges.
- The review has heard evidence that students have various motivations for undertaking an EMES degree programme, which can range from ethical motivations to a simple interest in the subject. These different motivations, however, can play a role when a graduate is seeking employment. For example

those who were motivated by ethics to undertake an environment-related degree programme may choose not to seek employment in industries related to fossil fuels.

- The cyclical nature of particular industries (such as oil and gas industries) will impact on the time that some graduates may take to gain employment in their chosen field.

5.49 Many EMES graduates undertake postgraduate (PG) study to meet the specific skills needs of industry. This is potentially a reflection of the less vocational nature of subjects within natural sciences so that specialisation at the PG level can, in many cases, be a way of meeting employer needs. There is a definite balance between broad content of curricula which can facilitate entry into the wider employment market and specialist knowledge and skills which allow graduates to find specific roles. This is perhaps reflected in the stakeholder findings that graduates struggle to translate theory into practice in the workplace.

5.50 As with Biological Sciences, A-Level Mathematics is not required for entry onto all undergraduate programmes within the EMES subject group. Again, the stakeholder survey findings were supported at the focus group, which highlighted a lack of numeracy among some students, particularly in Geology and Environmental Sciences. This may have been compounded by the loss of AS-Level Mathematics and the narrow mathematics curriculum at A-Level.

5.51 Field and laboratory work are both important for students and employers in these disciplines because they provide practical skills and could also be a good way of developing wider soft skills such as teamwork, project management, and wider interpersonal skills. However, focus group attendees highlighted that such work has a high cost and students themselves are expected to meet any additional costs of fieldwork. There are also costly insurance implications for HE providers.

5.52 In line with broader review findings, students who undertake work placements during their studies are more likely to meet the needs of employers than those who do not. However, the provision of placements relies on engagement between HE providers and business/industry. The review recognises that this can be particularly challenging for some disciplines within the EMES subject group who engage with industries where employment is related to price or demand fluctuations for commodities. For example, the focus group held to discuss employment outcomes of EMES' graduates described engagement with some oil and gas employers as 'patchy' reflecting the difficulties these industries face in accurately predicting their employment needs. The focus group also indicated that engagement with employers more broadly may be lacking due to a perception among some parts of the HE sector that they are engaged in an academic, rather than vocational, discipline.

5.53 There are various accreditation systems for the diverse range of programmes within the EMES subject group. Some of these are already well established, while others are still emerging. This is further challenged by accrediting systems that span degree programmes of the same name but which are differentiated by being either science- or policy-focused in their content. However, accreditation or a common framework that

might guide the various systems of accreditation, could provide EMES disciplines with a forum for common engagement between the HE sector and industry.

5.54 The focus group agreed with the review's findings that this subject group would benefit from an additional, more in-depth consideration of the employment outcomes of its graduates.

Agriculture, Forestry, Animal Sciences and Food Sciences

Background

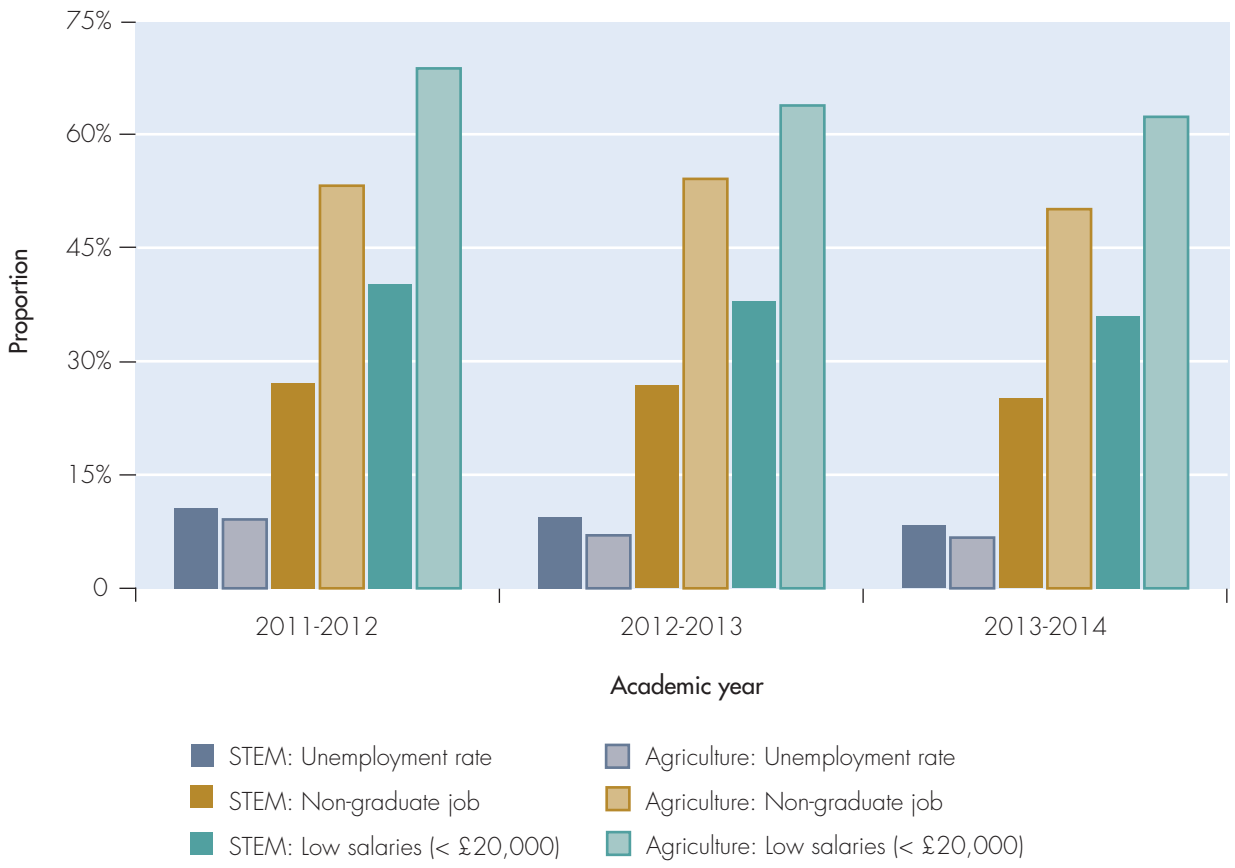
5.55 In 2014-15, there was a total of 2,670 full-time first degree entrants to programmes in the Agriculture, Forestry, Animal Science and Food Science group of disciplines. In comparison to Biological Sciences and EMES, there was a higher proportion of mature students than young entrants to these disciplines, 620 mature students, compared to 2,050 young students. There were 1,905 female students, compared to 765 male students and 2,190 white students compared to 165 BME students. Of the young students, 205 were from a low participation neighbourhood.

5.56 This group of disciplines shows very high levels of graduates in non-graduate roles and very high levels of graduates earning low salaries. These issues persist and appear to worsen in the long term with the LDLHE survey for the 2008-09 cohort indicating that 60.9% of employed graduates are in non-graduate roles and 43.4% of employed graduates are earning 'low salaries'.

5.57 The number of students studying Forestry is small (110 undergraduate entrants in each of academic years 2012-13 to 2014-15, of which 30 were commencing a full-time first degree course), and therefore a source of concern in itself. As a result, the data available from DLHE contains too small a sample to enable robust statistical conclusions to be drawn (between 20 and 25 graduates in each year 2007-08 to 2012-13, and 30 graduates in 2013-14) and so we exclude them formally from further consideration.

5.58 Figure 12 shows the employment statistics for the Agriculture, Animal Sciences and Food Sciences group (excluding Forestry) broad subject group from 2011-12 to 2013-14.

Figure 12 Employment outcomes of UK-domiciled full-time first degree graduates from STEM (including Agriculture and Forestry) and Agriculture (NOT including Forestry) six months after leaving HE: graduates from publicly-funded English HEIs, 2011-12 to 2013-14



Source: HEFCE analysis of the HESA standard qualifications obtained population, 2011-12 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE.

Review findings

5.59 In common with the previous two discipline groups, the focus group held to discuss the broad Agriculture subject group indicated a strong need for analysis to be conducted at the detailed subject level. The range and diversity of the degree programmes included under the HEFCE Agriculture broad subject group is already acknowledged by HEFCE and the HE sector. This diversity is demonstrated in the employment outcomes at six months across the three disciplines and over three cohorts of students shown in Table 6 and Figure 13.

Figure 13 Employment outcomes of UK-domiciled full-time first degree graduates from Agriculture, Animal Sciences and Food Sciences six months after leaving HE: Graduates from publicly-funded English HEIs, 2011-12 to 2013-14

Source: HEFCE analysis of the HESA standard qualifications obtained population, 2011-12 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE

Table 6 UK-domiciled full-time first degree graduates – Employment outcomes six months after graduation by sub-discipline, 2011-12 to 2013-14.

Discipline by employment outcome indicator	2011-12	2012-13	2013-14
Agriculture: Unemployment rate	7.1%	7.4%	5.2%
Animal Science: Unemployment rate	12.2%	7.4%	8.1%
Food and Beverage Studies: Unemployment rate	6.5%	4.0%	5.6%
Agriculture: Non-graduate job	48.8%	44.0%	38.6%
Animal Science: Non-graduate job	70.3%	72.4%	70.9%
Food and Beverage Studies: Non-graduate job	24.6%	33.8%	24.2%
Agriculture: Low salaries	69.5%	57.4%	52.5%
Animal Science: Low salaries	88.8%	82.2%	83.2%
Food and Beverage Studies: Low salaries	31.0%	38.9%	39.2%

Source: HEFCE analysis of the HESA standard qualifications obtained population, 2011-12 to 2013-14. Graduates who subsequently provided a valid response to the DLHE survey six months after leaving HE

5.60 The evidence and findings of the review related to the Agriculture broad subject group are therefore presented according to the following three detailed disciplines: Agriculture, Food Sciences and Animal Sciences. This disaggregates the broad subject group into those that are of most interest to the review where subjects are deemed to be 'high value' and where disaggregation still enables meaningful data analysis.

5.61 Respondents to the stakeholder survey who represented Agriculture and related disciplines, indicated a large difference between HE providers and business/industry in terms of their assessment of whether graduates are meeting employability requirements of employers. Just over 20% of employers agreed that graduates are meeting requirements with the remainder either disagreeing or neither agreeing or disagreeing. Over 60% of respondents from HE providers thought Agriculture and related graduates were meeting requirements.

5.62 The stakeholder survey suggested that the following issues might be affecting the employment outcomes for Agriculture, Animal and Food Sciences graduates:

- Graduates lacking 'soft skills'
- Graduates lacking work experience
- Graduates struggling to translate theoretical knowledge into practice

5.63 This shows a similar pattern to that emerging for the Biological Sciences and EMES graduates although focused on fewer issues.

5.64 Unlike many STEM disciplines, graduates from many of the disciplines within the Agriculture broad subject group enter clearly defined industries reflecting the often vocational nature of the degree programmes. Attendees at the focus group were representative of these distinctions. There is therefore some interesting contextual information to take into account for some of the disciplines within this group. For example, the focus group highlighted that many agricultural jobs include benefits such as accommodation as part of their overall salary package. This level of detail is not captured within the destinations data and may therefore be presenting a distorted view of the salary levels for graduates from agriculture degree programmes. It also distorts the picture at the broad subject level. To capture adequately the differences for each of the three disciplines within the broad subject group, the remaining section of this analysis is presented according to: Food Sciences, Animal Sciences and Agriculture.

Food Sciences

5.65 Within the Food Sciences subject group it is possible to distinguish between Food Sciences and Food Technology. Food Technologists tend to be employed in more engineering-focused roles as opposed to Food Scientists who are engaged more in food product development and safety. Food Scientists are engaged at all levels of the food supply chain.

5.66 The food industry is diverse with large employers able to offer established career routes and many small employers unable to offer a similar career path for their employees. The food industry is experiencing rapid change which has placed an even

greater importance on graduates being equipped with the skills and ability to adapt and update their knowledge and apply this to new and emerging technologies and contexts throughout their careers. Employers also recruit graduates from a range of disciplines including from the applied sciences because they are interested in tackling tasks that require a wide spectrum of skills which will become even wider.

5.67 The focus group confirmed findings from the stakeholder survey that some Food Sciences graduates lacked soft skills but also personal drive and individual resilience. Developing the soft skills and 'work readiness' of graduates continued to be a challenge for HE providers, compared to technical skills. The value of work experience is recognised for Food Sciences graduates and there is currently a sufficient supply of placements, although this is usually concentrated in larger employers.

5.68 The Institute of Food Science and Technology (IFST) has recently introduced a new accreditation system for Food Sciences degrees. As the accreditation system is still in its infancy, it is too early to accurately assess whether there are any impacts on outcomes of graduates from accredited programmes.

5.69 The focus group highlighted the appetite for increased engagement between HE providers and the Food Science industry. Although the lack of a coherent employer voice for the agri-food sector is acknowledged, the Agri-Tech Leadership Council[28] is currently investigating how it might provide or facilitate this role.

5.70 The review is content that there is little evidence to indicate a problem with employability of graduates for this section of the overall discipline group. However, we would observe that the nascent accreditation system should be fully supported by employers and HE providers to ensure closer engagement.

Animal Sciences

5.71 Animal Sciences comprises a relatively large number of entrants, compared to Agriculture and Food Sciences, with 2,640 undergraduate entrants in 2014-15[29]. Animal Sciences students may be seeking a diverse range of roles related to animal management or care of companion animals. In many cases these roles are charity or voluntary roles that attract low salaries. Other students want to take up higher salary/skilled roles related to commercial animal science/agri-tech industries (animal nutrition being but one example).

5.72 Animal Sciences covers a broad range of disciplines and industries, is a growth area and is becoming more scientific in nature. There is considerable overlap in particular between Animal Nutrition and Food Sciences disciplines. There is significant industry demand for animal scientists, particularly animal nutritionists. However, the exact nature of this demand, and the types of roles available to animal scientists, would benefit from greater understanding. A large proportion of roles that graduates enter are not classified as 'graduate-level' roles, but attract a significant salary, for example veterinary nursing. The classification of some agri-tech roles also needs to be better understood. This is

28 https://www.gov.uk/government/publications/agri-tech-leadership-council-membership/agri-tech-leadership-council-membership
29 At publicly-funded English HEIs.

reinforced by KIS course level data which clearly demonstrates that many Animal Sciences graduates fall into the 'non-professional' classification.

5.73 There are limitations of the data available to assess the employment outcomes of graduates from Animal Science disciplines because a large number of providers are Further Education Colleges (FECs) delivering HE courses who are not captured by the DLHE survey data. Focus group attendees pointed to the *'Review of provision of land-based studies'* (2007), commissioned by HEFCE[30], which showed that as much as 40% of land-based HE activity was taking place, in relatively small numbers, across a wide range of FECs. Any future work to investigate the employment outcomes of graduates might consider information on performance/outcomes from FECs via the KIS/Unistats course level data.

Agriculture

5.74 Agriculture and its associated industries are undergoing rapid change. These industries are increasingly and quickly becoming more technology-based, with a trend for larger, more innovation-focused farming. The technology expansion extends across many areas but includes big data, agri-metrics, physics, biology and many areas of engineering. 'Food production' was universally considered potentially an area of growth in demand for graduates from a range of disciplines by employers.

5.75 Misperceptions and stereotyping of farming and farm management-related jobs means that graduates from other disciplines are often put off from exploring potentially rewarding careers. This finding is supported by a report by the National Centre for Universities and Business (NCUB)[31] which confirms that agriculture is not a priority destination for a large majority of graduates despite opportunities.

5.76 The focus group asserted that there are a range of roles in Agriculture that are classified as 'non-graduate', but which attract relatively high salaries and that are, in practice, comparable to graduate level roles. Despite some jobs being classed as 'low salary roles', there are a range of farm management roles where graduates receive non-financial benefits (such as housing) which need to be taken into account in the employment outcomes analysis. A more thorough investigation of the employment outcomes of Agriculture graduates may help to clarify the extent of the issue of role classification. Agriculture graduates are also in demand internationally.

5.77 While industry is stepping up efforts to address a shortage of agricultural skills with a series of sector-wide initiatives, the exact nature of the skills gap is unclear. This is further hindered by a lack of a coherent employer voice and, what the focus group felt was a resistance to 'professionalisation' of the agriculture sector. The focus group suggested that the 'Food Chain' could be adopted as the basis for building a better understanding of employer skills requirements and the Agri-Tech Leadership Council was developing thinking around this.

5.78 Agriculture graduates benefitted from a series of informal and often short work placements, which the current destinations data is unable to record.

30 http://webarchive.nationalarchives.gov.uk/20120118171947/http://www.hefce.ac.uk/pubs/rdreports/2007/rd09_07/

31 http://www.ncub.co.uk/reports/fe-talent.html

5.79 Like the previous two subject groups, the employer expectations of Agriculture graduates with regard to an ability in mathematical and quantitative statistics was highlighted as an issue in both the stakeholder survey and the focus group. Anecdotally, the ability of students across the disciplines to interpret data and derive information and conclusions is poor with basic numeracy also a recognised issue. Mathematics and statistics content is included in most agri-food degrees because much of the other content that forms part of the degree courses depends on it. Currently requirements for mathematics vary between HE providers and some providers have no requirement for students to have undertaken A-Level maths. The focus group argued that mathematics skills delivered at the secondary school level require further investment to improve numeracy of school leavers. The focus group also highlighted that the Quality Assurance Agency for Higher Education (QAA) subject benchmark statements which include reference to the types of mathematics skills that a degree ought to provide may no longer align with industry expectations.

5.80 The review has acquired quantitative and qualitative evidence that suggests there are some difficulties for the employment outcomes in some of the disciplines within agricultural and related disciplines. At the same time there are reasonable hypotheses to explain some of these findings for an employment market that is very broad and diverse. The review asserts that on balance, taking account of the rapidity of current and future changes in the various components of the supply chain from agriculture to food as well as the importance of the agri-food sector to the UK economy, it is advisable to consider this group of disciplines in more detail than has been possible here.

Engagement with professional bodies and representative organisations

5.81 In parallel with facilitating focus groups to discuss three groups of disciplines with graduate employment outcomes of concern, the review also invited a range of PSRBs to input their views and knowledge on the employment outcomes of graduates from a further group of STEM disciplines. This group comprise those disciplines highlighted in Stage 2 of the review as showing some evidence of poor employment outcomes against the three indicators and where the review's Advisory Group felt further information was required. The disciplines where we invited views and the responses to that invitation are outlined below.

5.82 **Pharmacology and Pharmacy** – the review was concerned about the low salaries of graduates revealed in the DLHE survey. The review received responses from the Royal Pharmaceutical Society and the British Pharmacological Society. For Pharmacy, the review was satisfied that no further action was required because Pharmacy graduates must undertake a pre-registration training year which attracts a low salary. For Pharmacology, many graduates continue into further study because a postgraduate qualification is usually necessary for professional employment. It is a direct consequence that those who do not choose that route (a small fraction) have relatively poor employment outcomes.

5.83 **Bioengineering, Biomedical Engineering and Clinical Engineering** – the review received responses from the Institution of Engineering and Technology (IET), IMechE, and the Institute of Physics and Engineering in Medicine (IPEM). These responses indicated that the demand for Biomedical Engineering graduates was high but the expectation was that graduates had progressed to postgraduate study before seeking employment. There was recognition that the link between HE and industry needed to be strengthened. There is also a range of accrediting bodies for Biomedical Engineering degree programmes. The responses indicated that this was a highly skilled industry where the demand for high quality graduates would continue, but matching the nature of the demand in a rapidly evolving industry needs to be considered.

5.84 **Aerospace Engineering** – responses were received from the Institution of Mechanical Engineering, the Engineering Employers Federation (EEF), and, via the online survey, from the Royal Aeronautical Society (RAS). The responses supported our tentative conclusion that we should have some concerns about the employment outcomes of these graduates. In particular, there seems to be a disconnect between HE providers and their graduates and SMEs so that most graduates focus their careers planning and engagement around larger employers. There are also concerns over the work readiness of aircraft maintenance graduates, a course that was traditionally offered as an apprenticeship.

5.85 **Chemical Engineering** – responses were received from the Institution of Chemical Engineers (IChemE) which emphasised that graduates from integrated Masters programmes (MEng) enjoyed more positive outcomes than those graduating with BEng. IChemE indicated that graduates may take time to consider their employment options in the immediate aftermath of their degree programme which may help to explain the trends observed in the six-month DLHE data. IChemE stated its intention to undertake a graduate survey around Easter 2016, which is likely to provide more information on the destinations of Chemical Engineering graduates. In general, Chemical Engineers command the highest salaries among engineering graduates, driven by demand and so, when this is considered alongside the suggestion above on graduate behaviour post-graduation, we consider it unlikely that there are significant employment issues.

5.86 **Communications Engineering/Systems Engineering** – responses were received from IET and EEF. The response from IET indicated that from among the 1,300 degree programmes that it accredits, only 70 are primarily communications-focused and 150 are systems engineering-related. The topics of concern are therefore in the minority among the programmes within their remit and involve rather few students. They comment that in their experience accredited programmes in these areas are attractive sources of graduates for employers but that unaccredited programmes with similar titles may be focused on aspects other than engineering and sectors with different employment characteristics. The IET also pointed out that there is a trend towards the take up of more general degree titles with a more wide-ranging content that allows later specialisation. The IET pays special attention to the programme title during accreditation to ensures it represents correctly what can be expected from graduates by industry but advocates enhanced interaction between HE providers and industry. EEF in its response endorses

the idea that engineers are much in demand because it reports that over 63% of its membership have recruited graduate engineers in the last the past three years and that this demand continues. It emphasises that attitudes are as important as aptitude in graduate recruits and it cites industrial experience including placements, the practical application of ideas and mathematical skills are essential attributes of graduates that are not present in all applicants. Enhanced interaction between business and HE is included in their wishes for the future. The relatively small number of programmes and graduates with poor employment outcomes at present does not suggest there is a major issue to be resolved at present.

5.87 **Physics** – a response was received from the Institute of Physics (IoP) which highlighted the demand for Physics graduates and that a high proportion enter further study especially doctoral studies. A delay in the take up of PhD study may be leading to employment data suggesting poor outcomes six months after graduation. High numbers of graduates are also concentrated in high tariff institutions. The offer and take up of work experience is good with 67% of Physics departments, who responded to an IoP survey, stating that they offered placements of 6-12 months within their undergraduate degree programme. There is no immediate or large scale cause for concern specific to this subject.

5.88 **Chemistry and Materials Science** – a response was received from the RSC which drew on its own pay and reward survey. Graduate destinations are broadly split between those who enter industry in traditionally more technical and therefore lower paid roles, and those who continue into research. Growing numbers of graduates are employed in SMEs and the RSC runs the EnterprisePlus work placement scheme which helps to match students with SMEs. 81 of the 350 degree programmes that the RSC accredits incorporate a year-long placement in industry with many students gaining permanent employment with their placement employer. The RSC provides outcomes-based accreditation with graduates being eligible for Chartered Chemist (CChem) status. There is no immediate or large-scale cause for concern specific to these disciplines.

5.89 **Mathematics** – a response was received from the Institute of Mathematics and its Applications (IMA), which is an organisation that offers accreditation for courses leading to Chartered Mathematician designation. Graduates often continue into further study from HE providers where the undergraduate curriculum has prepared graduates for this level of study. Others will undertake broader employment. The IMA recognises that employability needs to continue to be addressed in undergraduate degree programmes. There is no immediate or large-scale cause for concern specific to these disciplines.

5.90 **Engineering Design** – responses were received from the IMechE, IET, the Institution of Engineering Designers (IED) and the Design Council. All responses acknowledged the small numbers of Engineering Design students and graduates, but the importance of a field that has the potential to impact significantly on the modern economy. The Design Council pointed to continuing and rising demand for Design graduates at the broadest (STEM and non-STEM) level with both technical and broader skills. Design Council-led initiatives such as the Design Academy are helping to address this demand. However, there are concerns over a potential 'cliff edge' in the supply of Design graduates particularly to the important automotive industry where the supply may have

a significant mismatch with demand. Many students and graduates are less keen to consider design roles in the manufacturing and engineering sectors which are seen as less creative. The Design Council also pointed to the need for a holistic approach to Design which avoided a division of STEM and non-STEM degree programmes. All the bodies responding are able to deliver accreditation under the Engineering Council framework and there would seem to be a need for those bodies to come together with the HE sector and relevant industries to ensure a better match between supply and demand.

Summary

5.91 The responses from PSRBs and representative organisations have provided valuable context to many of the concerns we have raised in relation to a range of STEM subjects. Some of the responses have provided the review with rational explanations for a particular employment outcome and provided reassurance that concerns are not valid. However, in other subjects, responses supported our concerns and presented a case for action to address what may be minor, or developing, concerns. We conclude that these concerns may be best tackled by engaging a group of interested parties rather than undertaking an in-depth review.

Cross-cutting themes

5.92 A number of common themes have emerged during the review's evidence gathering. These themes were initially highlighted in responses to the stakeholder survey and reinforced during the three discipline-specific focus groups and in our engagement with the PSRBs and representative organisations. Although the themes were not central to the review's original remit it is our view that they should be set out explicitly here.

5.93 A summary is outlined below.

- **Industry is changing at a rapid rate** – A number of STEM industries are developing at a very fast pace which is in turn likely to place increasing pressure on the need to ensure course provision and graduate skills are aligned with current industry trends and technologies. The rate at which the relevant components of STEM courses can be changed in HE at present is often significantly slower.
- **Graduates need an ability to upskill and adapt** – The fast pace of change within many industries where the skills of STEM graduates are required is also likely to intensify the focus on graduates being equipped with the ability to adapt their knowledge and skills. Adaptability and personal resilience are likely to be important as graduates need to be prepared for a lifetime of learning to keep pace with industry change. In this context a thorough grasp of the fundamental principles of a STEM discipline will be vital.
- **Work experience improves the employability of graduates** – Experience of the work place is highly valued by employers and provides graduates with clear benefits including developing soft skills and getting an insight into the workplace. Whereas the supply of work placements is adequate for some disciplines, in other areas it is below the demand from HE providers. It is almost certainly true that there

cannot be enough full-year industrial experiences to provide one for every STEM graduate even if that were desirable.

- **Different employers want different things** – Soft and work-readiness skills are highly valued by all employers and evidence seems to indicate that some employers continue to struggle to recruit graduates with these skills. However, in many cases, the nature of the skills demand from employers is either unclear or diverse. Identifying the precise skills requirements for each and every STEM industry may be undesirable, however increased levels of engagement between STEM employers, professional bodies and HE providers would help to ensure that graduates are being provided with the skills and knowledge that will enable them to thrive in increasingly competitive marketplaces. It is certainly true that the efforts devoted to improving soft skills by HE in the last few decades have had a significant positive impact, but it should also be recognised that there is the potential for requirements to change over time as the workplace and industries evolve. The review also recognises that it is unreasonable to expect that the burden for supporting the development of soft skills in students and graduates should fall entirely on university lecturers and academics who, in some cases, are not best equipped to meet the need. We are clear that the support to help graduates develop their soft and work ready skills should be delivered in partnership between course leaders, university careers staff and employers.
- **Careers advice should be more systematic and robust** – providing tailored careers and recruitment advice and guidance to STEM students during the course of their degree as well as in their final year would help them to develop a better understanding of the opportunities available to them in what is, often, a complex and diverse set of industries. In some cases, graduates do have the requisite skills and knowledge, but lack an ability to articulate these adequately in applications and at interviews and in assessment centres.
- **STEM disciplines within HE providers and employers of STEM graduates need to find ways to engage** – a one size fits all approach to engagement is not the ideal. For example, Energus is an organisation which bridges the gap between universities and employers in the nuclear industries by developing graduates through a training and skills programme. The review was interested to hear of this example of a concerted, coordinated effort by the nuclear industry, to add value and meet the needs of employers in its sector by addressing the skills gap.

6 Conclusions and recommendations

6.1 The primary aim of the review was to establish which STEM disciplines, in addition to Computer Sciences, suffer from relatively poor employment outcomes and which would therefore warrant specific consideration through future targeted work. The review sets out recommendations below which identify a number of disciplines that fall into this category. There are a small number of other disciplines of lesser concern where some work directly by interested parties might enhance the employment outcomes for some graduates. We suggest the area of that work and who might undertake it. In addition, during the course of its work the review has also identified a series of issues which have been prominent throughout the evidence gathering and which appear to cut across many STEM disciplines.

Biological Sciences

6.2 The umbrella discipline of Biological Sciences as it appears in the HESA datasets comprises a large variety of different sub-disciplines including Biology, Botany, Zoology, Genetics, Microbiology, Molecular Biology, Biophysics and Biochemistry[32]. Evidence available through the HESA destinations data, the review's separate stakeholder survey, and the views gathered through a targeted focus group discussion of Biological Sciences have established that there are clear grounds for concern about the graduate employment outcomes across these disciplines. The evidence points to the need for a future piece of work to identify in more detail what lies behind these outcomes and what steps should be taken to improve the situation.

6.3 Identifying the causes of the outcomes for graduates from Biological Sciences disciplines has been challenging and this has been particularly difficult in relation to issues around employer demand. Evidence submitted to the review has emphasised the difficulty of identifying the nature of employer demand for graduates from these disciplines and, therefore, whether there is evidence of unmet demand in the economy[33]. Evidence from the review's stakeholder survey and from the Biological Sciences focus group indicates that graduates from these disciplines tend to go on to take up a wide variety of different types of role in different sectors and industries, and it is clear that there is no sense in which there is a defined 'Biological Sciences industry'. This challenge is not unique to Biological Sciences, however, and does highlight a difficulty that the review has encountered at a number of points. Mapping HE STEM disciplines onto the roles available in industry has been highlighted as a difficulty by stakeholders on a recurring basis throughout the review. A lack of alignment between the way in which industries are structured and the disciplines offered by HE providers has provided a challenge for the review in terms of being accurately able to measure the gap between the supply and demand for graduates.

32 https://www.hesa.ac.uk/component/content/article?id=1787

33 The ABPI's report *Bridging the skills gap in the biopharmaceutical industry* provides more detail on the nature of the skills gaps that appear to present in relation to Biological Sciences disciplines aligned with the biopharmaceutical industries and which suggest that, within the pharmaceutical industry, there is demand that is not being met in relation to areas aligned with Biological Sciences. http://www.abpi.org.uk/our-work/library/industry/Documents/Skills_Gap_Industry.pdf

6.4 The review identified a number of themes and issues that it would be helpful to consider in any future work on Biological Sciences disciplines:

- The nature of employer demand for graduates from Biological Sciences disciplines needs to be clarified, and, in particular, work should attempt to articulate whether there is an unmet demand for graduates, or whether the reported unmet demand relates to skills at a different level, for example at technician-level.
- It would be helpful to clarify how the supply (both numbers but also the particular types) of Biological Sciences graduates reflects employer demand for graduates with particular skills, and how information on this demand, in form of careers prospects and advice, could be made available to prospective students.
- It will be important to address concerns that have been raised by both HE providers and employers around the quality and nature of graduates' skill sets, including their practical skills and ability at team-working.
- Future work should also address concerns that have been raised about the abilities of graduates in Biological Sciences in Mathematics and, in particular, in quantitative analysis. Evidence has hinted at potentially two separate problems; the first concerned with mathematics attainment prior to taking up a HE course and the second related to the exposure to quantitative analysis and statistics during undergraduate programmes.
- There was evidence to suggest that both students and graduates in Biological Sciences in some circumstances were suffering from a lack of information on the full range of career opportunities that might be available to them in the industries related to their discipline as well as opportunities outside of industries directly related to Biological Sciences.
- The impact on graduate employment outcomes of the accreditation system recently introduced by the Royal Society of Biology should be considered in any future work.

Recommendation 1 – Biological Sciences

Further targeted work is needed to explore in more detail the reasons for the relatively poor employment outcomes of Biological Sciences graduates and to set out solutions for improving these outcomes.

Earth, Marine and Environmental Sciences

6.5 In much the same way as Biological Sciences, Earth, Marine and Environmental Sciences comprises a broad range of sub-disciplines with degree programme content that can vary substantially. Whereas for the Biological Sciences disciplines it has been possible to examine HESA data to identify that poor employment outcomes persist across the array of sub-disciplines, the data available on the EMES disciplines is much less clear and unequivocal, and it has been much more difficult to identify the specific location of any problems. The review therefore recommends that additional work needs to be done to unpick whether the outcomes observed at the headline EMES level present across the array of sub-disciplines or whether the problem is located in one or two specific sub-disciplines. As part of this work, investigation may be needed into whether more granular data is required to pinpoint the specific nature of the problem.

6.6 Mirroring the range of sub-disciplines that sit under the EMES umbrella, the review has heard evidence that there is a large number of academic accreditation systems which provide a variety of frameworks used to define standards across the range of sub-disciplines. The review has also heard that academic accreditation is viewed by many stakeholders as one of the more robust mechanisms for ensuring consistency of standards across a set of disciplines. However, views at the EMES focus group suggested that many EMES courses were often, individually, subject to different types and levels of accreditation, generating confusion and a significant burden on HE providers. Given the potentially valuable role that the review has heard accreditation can play in ensuring that degrees are meeting consistent standards and providing clarity for students, employers and HE providers, the uncertainty surrounding the accreditation frameworks for EMES disciplines is concerning. Therefore, the review recommends that, as part of any future work covering EMES, consideration is given to how this picture might be clarified and the wide-ranging accreditation systems simplified or revised into a common accreditation framework to promote consistency and transparency.

6.7 One specific area which should also be addressed through future work, and which accreditation may play a role in, is the consistency of labelling of degree programmes. EMES sub-disciplines can include a large number of degree programmes which often share common titles, but which in practice have content that varies significantly. Future work on EMES graduate employment outcomes should seek to consider this and explore how revised systems of accreditation might help to improve the situation.

6.8 As with Biological Sciences graduates, the review found that, anecdotally, graduates from EMES disciplines tend to take up employment in a wide range of sectors and industries. Linkages were suggested between Earth Sciences degree disciplines (primarily Geology) and the petro-chemical and energy industries. The cyclical nature of some of these industries, in particular the oil-based industries, is likely to have a significant bearing on the graduate jobs market and, therefore, the review recommends that the unique characteristics of some of these industries are identified and considered in any future work on EMES.

6.9 It was also suggested to the review that graduates from EMES were likely to have a diverse range of motivations for wanting to study their degree discipline, which are

likely to have an effect on their choice of career and engagement with the jobs market. It was suggested, for example, that a proportion of Environmental Science graduates are likely to pursue employment in the not for profit sectors which may help to explain the observations arising from the data in relation to their poor employment outcomes. Future work should explore this issue and more and better information on the nature of how motivations interact with graduate employment outcomes may help to mitigate existing concerns.

Recommendation 2 – Earth, Marine and Environmental Sciences

Further work is needed to unpick and explore the nature of, and reasons for, the relatively poor employment outcomes of graduates from Earth, Marine and Environmental Sciences (EMES) degree programmes. Where clear problems are identified for particular disciplines within the EMES group, solutions should be proposed for improving outcomes.

Agriculture, Animal Sciences and Food Sciences

6.10 For Biological Sciences and EMES the review has been provided with evidence that the employment outcomes of graduates from these disciplines are sufficiently concerning to warrant further specific investigation. The issues surrounding the graduate employment outcomes for Agriculture, Animal Sciences and Food Sciences are, however, potentially more complex.

6.11 Based on the analysis in Stages 1 and 2, the review identified Agriculture, Animal Science and Food Science as disciplines of concern. The initial interrogation of HESA graduate destinations data indicated that a very large proportion of graduates from the three disciplines were in non-graduate roles, and were earning low salaries, six months after graduation. The findings also demonstrated that these outcomes persisted and, in some cases, worsened over time up to three and a half years after graduation. Concerns based on the HESA data were supported by evidence gathered through the review's online stakeholder survey, with 'Agricultural and Food Sciences' highlighted by survey respondents as one of the disciplines where graduates were not meeting the employability requirements of employers. These separate pieces of evidence, therefore, pointed to Agriculture, Animal Sciences and Food Sciences as disciplines that ought to be followed up through additional scrutiny in Stage 3.

6.12 The evidence provided to the review through the Stage 3 focus group on these disciplines, however, presented a more complex picture of the issues that might be impacting on graduate employment outcomes. A key message coming out of the focus group was that the findings set out in terms of the HESA data were unlikely to provide a comprehensive view of graduate outcomes. Concerns were raised, for example, with the methodology and definitions used to identify 'graduate roles', with stakeholders suggesting that there were a number of roles in industries related to the three disciplines that would not formally be captured under the current commonly used definitions. An

example that was provided related to Animal Sciences, where Veterinary Nursing was highlighted as a job role as that would not be formally classified as a 'graduate role' under the definition of a 'graduate role' as one falling within the three Standard Occupational Classification major groupings of 'managers and senior officials', 'professional occupations' and 'associate professional and technical occupations'. However, this was a role which was a recognised destination for a number of Animal Sciences graduates. According to views expressed at the focus group, on the basis of this definition Veterinary Nursing roles were categorised as 'non-graduate' despite generally attracting salaries in the region of £30,000 and requiring skill sets comparable with other graduate-level roles.

6.13 The focus group also raised concerns around the data relating to the employment picture for Agriculture graduates. In a similar vein to the Animal Sciences example, the group suggested that, whilst the HESA data presented a picture of a large proportion of Agriculture graduates earning low salaries, their experience of graduate outcomes was more subtle. It was suggested that a number of Agriculture graduates that go on to become agricultural workers in practice derive a number of non-salaried benefits which are not factored into the data. It was submitted that many agricultural roles are subject to terms of employment which include benefits related to workers' subsistence, for example food and accommodation. It was suggested that these types of non-salaried benefits should be included as part of any analysis of graduate employment outcomes and that, therefore, the headline statistics concerning the proportion of graduates earning low salaries need to be treated with caution.

6.14 The review found these arguments to be persuasive. However – based on additional evidence the review had gathered from the online stakeholder survey and in light of areas of concern highlighted by the focus group itself – it did not consider that they alone provided sufficient evidence to enable the Agriculture, Animal Sciences and Food Sciences disciplines to be discounted from further investigation. Importantly, the focus group provided additional context and background to the industries which tend to rely on the skills of graduates, and which provided an additional rationale for further investigation of the disciplines. Significantly, focus group attendees suggested that some of the primary beneficiaries of the skills of graduates from these disciplines were the industries and sectors that comprise the UK's food supply chain. To this extent, it was suggested to the review that, in practice, the investigation of Agriculture, Animal Sciences and Food Sciences was an investigation of disciplines that could be more accurately titled as 'Agri-Food'.

6.15 The UK's agri-food supply chain is comprised of a huge number of different industries and sectors, each with varying types and sizes of business that contribute to the UK having a secure and stable food supply. The entire agri-food supply chain, from agriculture to final retailing and catering, is estimated to contribute £96 billion or 7% of gross value added to the UK economy. Employment for the whole food supply chain that includes agriculture and fishing is estimated at 3.8 million[34]. The supply chain when viewed as an end-to-end system is extensive. The Government's 2013 Agri-Tech Strategy

[34] https://www.gov.uk/government/publications/uk-agricultural-technologies-strategy/uk-agricultural-technologies-strategy-executive-summary

sets out a range of constituent parts which themselves are each supplied by and composed of a wide range of different types of businesses and organisations: public and private sector agricultural research (throughout the supply chain spanning seeds, agrochemicals, machinery, engineering), inputs across arable and livestock agriculture, horticulture, food processing and packaging, and finally retailing by globally recognised brands. Stakeholders at the focus group submitted that graduates from each of the Agriculture, Animal Sciences and Food Sciences disciplines flow into the industries and sectors that service the agri-food chain at multiple different sections of this supply chain. We have not had the resource within the confines of this review to interrogate existing HESA data on the flows of graduates into distinct industries and job roles and so it has not been able to investigate this further. However, it remains likely that there are substantial sections of the Agri-Food chain that are dependent on the skills of graduates from these disciplines.

6.16 In addition to the size and complex nature of the agri-food supply chain and the different types and levels of demand for Agriculture, Animal Sciences and Food Sciences graduates, the fast-paced technological development that underpins many of the industries comprising the supply chain was raised as a specific area of concern. A strong message has been put forward to the review that suggests that many of the composite parts of the UK Agri-Food supply chain are increasingly subject to complex and fast paced technological advancements which, if the supply of graduate skills and knowledge to deliver these advancements is to be maintained and updated, requires coordinated effort to address. The NCUB's recent report *Leading Food 4.0: Growing Business-University Collaboration for the UK's Food Economy*[35]delves into and recognises many of these issues, suggesting that the 'food revolution is likely to be knowledge-intensive, collaborative and integrative. It may be built on big data, nano-technologies, genomics, and communications technologies.'

6.17 A specific example of the technological advancements permeating the agri-food sectors was highlighted in relation to agriculture, where workers are increasingly being exposed to, and expected to work with, an expanding range of technologies which require new and different types of skills. Increasingly, agricultural farm workers are, for example, being required to adopt and use technology to monitor livestock and crop growth/health; skills which have never previously been required in these types of role. There are clear links to be made here with the growth of the UK's digital economy, with a pattern of increasing reliance on digital skills appearing across a range of industrial sectors and job roles. In making its recommendation, the review is proposing a programme of work that seeks to 'future proof' the Agri-Food industries against skills gaps which have the potential to pose challenges to those industries and businesses seeking highly skilled graduates. Computer Sciences as a degree discipline provides an example of the challenges that employers can face if there is a mismatch between the supply and demand for high level skills. It is the review's hope that work to address the issues that have been set out above can assist the UK's Agri-Food sectors to anticipate some of these challenges and put in place appropriate mechanisms to effectively address them.

6.18 Despite Agriculture, Animal Sciences and Food Sciences being very different and distinct disciplines, the review has concluded that there is sufficient evidence to suggest

35 http://www.ncub.co.uk/reports/fe-report.html

that future work to explore their graduate employment outcomes would be warranted. The UK's evolving and fast-moving Agri-Tech sectors are of significant economic importance and this has been reflected in the increasing prominence that Agri-Tech has assumed in recent government thinking on UK industrial strategy. It is the view of the review that the sectors and industries that comprise the Agri-Food supply chain should come together to better understand these issues and to ensure that they can effectively address their skills requirements in the coming years.

Recommendation 3 – Agriculture, Animal Sciences and Food Sciences

Further targeted work is needed to explore the current employment outcomes for graduates in these disciplines across the whole of the set of businesses in the agricultural-food chain. The existing data is not sufficiently detailed to allow certainty about the situation now and the pace of change in the industry is likely to place new pressures on both HE and industry to match demand with the supply of appropriately skilled graduates. The study therefore needs to include consideration of the future as well as the past.

Additional STEM disciplines of concern

6.19 In addition to highlighting those STEM disciplines where there is a clear rationale that suggests that future investigations of their graduate employment outcomes would be beneficial, the review has also identified a number of disciplines where there are lower level concerns around graduate outcomes, but which warrant additional consideration. Aerospace Engineering, Biomedical Engineering and Engineering Design have been identified as disciplines which fall into this category.

Aerospace Engineering

6.20 Data from HESA indicates that, although the difference is not large, Aerospace Engineering graduates suffer from higher rates of unemployment six months after graduation relative to the STEM average unemployment rate. The review sought and received evidence from the Royal Aeronautical Society which supported the identification of some issues around the employment outcomes for graduates. Issues identified included graduates failing to engage with career opportunities based in SMEs in the aerospace sector and instead targeting jobs with well-established, large companies. Specific concerns were also highlighted with the work readiness of graduates going on to work in aircraft maintenance, a subject that had previously been offered as an apprenticeship and a more vocationally orientated route into the industry. The review recommends, therefore, that further conversations are convened between the relevant industrial representatives, professional bodies and HE providers for Aerospace Engineering. This engagement should seek to determine whether the concerns that have been raised with the review are real and

valid and whether additional effort is required to address specific issues in more depth. The review suggests a cast list that could comprise, but not be limited to: Universities UK (UUK), the Royal Aeronautical Society (RAS), IMechE, IET, ADS, the Science, Engineering, Manufacturing and Technical Alliance (SEMTA) and EEF.

Biomedical Engineering

6.21 HESA graduate destinations data initially indicated that there were concerns around the outcomes of graduates from Bioengineering, Biomedical Engineering and Clinical Engineering disciplines, with higher than STEM average levels of unemployed at medium tariff universities. Subsequently, the review wrote to IET, IMechE, the Institute of Physics and Engineering in Medicine (IPEM), the UK BioIndustry Association (UKBIA) and the ABHI. Responses seemed to indicate that future work would be warranted more specifically on the Biomedical Engineering discipline. Responses indicated that the demand from employers for Biomedical Engineering graduates was high once those graduates had undertaken targeted postgraduate study. Evidence indicates that the industries associated with Biomedical Engineering are still maturing and include a large number of small companies for whom recruitment of fresh graduates is often difficult. It was also suggested that Biomedical Engineering degree programmes are subject to a range of accreditation systems and, separately, that future demand for graduates from the discipline was likely to increase rapidly. The review recommends, therefore, that further conversations are convened between the relevant industrial representatives, professional bodies and HE providers for Biomedical Engineering. This engagement should seek to determine whether the concerns that have been raised with the review are real and valid and whether additional effort is required to address specific issues in more depth. The review suggests a cast list that could comprise, but not be limited to: UUK, IMechE, IET, Cogent, IPEM, BIA, ABHI and EEF.

Engineering Design

6.22 Data from HESA indicated that graduates from Engineering Design courses tended to suffer from higher than the STEM average levels of unemployment. To follow up on these concerns, the review wrote to IMechE, IET, IED and the Design Council. Information provided by the Design Council pointed to its worries that there was a rising demand for Design graduates from both STEM and non-STEM backgrounds and that it had concerns that future supply of design graduates would fail to meet projected demand. The Design Council also highlighted the need for both STEM and non-STEM industries which recruited design graduates to come together and adopt a more holistic approach to Design programmes, and to better articulate where demand for design graduates was likely to be located in future years. The review recommends, therefore, that further conversations are convened between the relevant industrial representatives, professional bodies and HE providers for Engineering Design. This engagement should seek to determine whether the concerns that have been raised with the review are real and valid and whether additional effort is required to address specific issues in more depth. The review suggests a cast list that could comprise, but not be limited to: UUK, IMechE, IET, IED, the Design Council, SEMTA and EEF.

Recommendation 4 – Additional STEM disciplines of concern

Further targeted work is needed to explore the graduate employment outcomes of Aerospace Engineering, Biomedical Engineering and Engineering Design graduates. Within all three disciplines the respective industry bodies, HE providers and professional bodies for those disciplines should work together to clarify the nature of their graduate employment outcomes and decide whether specific measures are required to address the concerns we have identified.

Work experience

6.23 One of the clearest findings from the evidence gathered by the review has been in relation to the benefits to graduate employment outcomes that are derived through work experience. Research from the UKCES's Employer Perspectives Survey sets out that relevant work experience was rated by two-thirds of recruiting employers (66%) as being a critical or significant factor looked for in candidates. This is not a new trend and much of the existing literature points to the improvements in graduates' skills, knowledge and 'work readiness' that are derived from formal work placements. However, the review's position is that this should be taken one step further with the message that any type of experience of the workplace would seem to benefit students. It is our view that all STEM students should have the opportunity to undertake some form of work experience during their studies, be that accessing industrial placements or less formal types of experience such as internships, voluntary work or holiday jobs. 'Opportunity' is a key word and it is important to reflect that for a number of students, formalised or structured work experience will not be the best solution for them. Given this, consideration by universities and employers needs to focus on how the key benefits derived from formal work experience could be embedded into existing degree curricula or generated through other types of interaction to allow all kinds of students to benefit.

6.24 The review has seen evidence of a number of types of interaction that could be considered in broadening the opportunities available to students[36]:

- Industry-led project work and competitions
- Student consultancies
- Industry-led teaching, lectures and seminars
- Purpose built industrial simulation facilities, for example, the 'Constructionarium'[37] in the field of Civil Engineering
- Mentoring by professionals from a wide array of industrial sectors
- Interdisciplinary peer review

36 The Royal Academy of Engineering's report Engineering Graduates for Industry sets out a number of case studies that could be considered: http://www.raeng.org.uk/publications/reports/engineering-graduates-for-industry-report

37 http://www.constructionarium.co.uk/

- A consortium approach: two or three organisations host placement students for part of their year in industry. One approach may be to target science parks where businesses are co-located.
- Financial incentives to remove risks for SMEs: the Royal Society of Chemistry's EnterprisePlus Industrial Placement Scheme[38] provides an interesting model whereby some of the financial risk for an SME of hosting a placement is reduced.
- Harnessing the experience of part-time and mature students to help support and influence full-time students
- Site visits and field trips
- National and international competitions

6.25 The review also wishes to emphasise that, where there is scope for expansion of provision and take up of work experience opportunities, maintaining the quality of these opportunities will clearly be an important consideration – simply increasing the supply of opportunities without regard to quality is not enough. Much evidence has also pointed to the challenges that face SMEs in taking on students for periods of work experience. Smaller sized companies account for a significant proportion of available work placement opportunities. Research by NCUB suggests that 'Small establishments account for 60% of placements'[39]. If the aim is to expand these opportunities further then future work looking at STEM graduate employment outcomes will need to consider how SMEs could be supported to overcome barriers to providing placements for, and hosting, students. In the report produced by the Royal Academy of Engineering the idea of a teaching tax credit for companies providing suitable opportunities, analogous to that available for research expenditure was floated as one means of encouraging the participation of small companies.

Embedding the development of soft skills into degree courses and improving work readiness

6.26 Alongside the evidence the review has gathered on HE provider and employer views on students undertaking work experience, another significant theme has been highlighted in relation to graduates' 'soft' and 'work readiness' skills. While the exact definition of these skills varies amongst employers, HE providers and students, they have consistently been raised with the review as an area of concern.

6.27 Through the online stakeholder survey, the discipline-specific focus groups and the correspondence the review has had with the range of professional bodies, much evidence has been gathered that indicates that employers are continuing to struggle to recruit graduates with adequate soft skills, which have been variously described as including skills relating to: delivering presentations, project management, commercial awareness and entrepreneurial skills and attitudes, report-writing and team-working as well as adaptability, personal resilience and a commitment to continuing professional development.

38 http://www.rsc.org/sme/industrial-placement-grants

39 http://www.ncub.co.uk/increasing-the-offer-of-work-experience-in-stem-subjects-can-demand-match-supply.html

6.28 The review took particular note of the issues raised around graduates' personal resilience. A number of employers referenced their desire to recruit graduates who not only possess a sound academic ability and knowledge base, but who have the ability to take those skills and knowledge and adapt it to a working business environment. In a number of cases, employers suggested that graduates making mistakes or failing in a particular work-based task was not in itself problematic. What employers in those cases were keen to see was a graduate learning to deal with failure and to adapt his or her approach to ensure future improvements. The HE environment is not immediately conducive to imparting these attributes because progression there is judged on success in a variety of assignments. In any event the development of these personal characteristics is a process associated with maturity and is as much achieved through non-academic pursuits as through a direct academic route. Nevertheless, the review suggests that HE providers and employers should consider how these issues might be addressed in any future thinking on soft skills.

6.29 The review recognises that HE providers and careers services have made significant efforts in recent years to seek to address the continuing issues around softs skills. Providers have pointed to efforts which include increasing the proportion of time during a degree programme that students work as part of a team, and specific work readiness modules which are assessed and form and explicit part of the degree programme itself. However, the concerns around soft skills that have been raised consistently with the review suggest that further efforts are required.

6.30 It is the review's position that students should have the opportunity during their degree programmes to develop skills that better prepare them for work to ensure that they are able to operate effectively in, and adapt to, the work environment. In particular, focus should be placed on developing students' personal resilience and equipping them to adapt their skills over the course of their working life so that they continue to meet the changing demands of industry. Specific focus is required in the following areas:

- The skills and knowledge of professionals from industry and/or careers services professionals should be used on a more regular and consistent basis to support academic staff in delivering and assessing soft and work readiness skills at the discipline level. Recognising that academic staff provide an essential role in ensuring that students learn the foundational principles of a discipline, more needs to be done to ensure that industry and careers service professionals can support this activity and play a leading role in embedding soft skills.
- Provision and assessment of soft skills needs to be embedded during the delivery of the main degree programme and should not be viewed or delivered as a separate 'bolt-on' component.
- Improving the ability of graduates to communicate with, and feel comfortable working across, teams comprised of colleagues from a range of disciplinary backgrounds should be a focus of future work, given the increasing interdisciplinary and interconnected nature of modern industry.

- The data analysis and quantitative methods skills of students on some degree programmes need to be improved and HE providers should consider whether more content focused on these skills could and should be provided and built into existing curricula.
- Developing greater awareness and appreciation of commercial considerations in graduates, including appreciation of profit motives, business planning and the importance of business interacting with and understanding client needs.

Ensuring STEM degrees are relevant to employer demand for skills

6.31 The review has heard evidence throughout its investigations that there are many existing examples of HE providers and employers working together to ensure that degree programmes are benefitting from continuous and consistent industry engagement. Much of this engagement takes place in an informal way with partnerships often forged between universities and businesses on a local and regional basis.

6.32 However, additional evidence gathered combined long standing concerns around STEM skills gaps which predate this review, suggest that much more needs to be done to support and facilitate closer engagement between universities and employers. HE providers in many cases already use Industrial Advisory Boards (IABs) – a group convened by the HE provider with representation from academics, employers and in some cases professional bodies. It is the review's position that there is scope for IABs to play a stronger and more active role in supporting the alignment of the relevant course provision with employment practice and to ensure that real-life experiences and examples of the workplace are more consistently embedded in provision. With the emerging TEF likely to place more focus in future on the importance of graduate employment outcomes, IABs could have a significant role to play in supporting providers to develop and deliver elements of courses and to help align them more closely with the jobs market. The mismatch between the disciplinary structure of the HE sector and the recruitment needs of companies militates against a disciplinary basis for such IABs but HE providers should ensure that the messages from such Boards are conveyed and penetrate at the individual Department level.

6.33 It is recognised that HE providers have to deliver STEM degree programmes that fit graduates for today's job market **and** a career of several decades during which practical skills and knowledge requirements may change. Close and continual engagement between HE providers and employers is therefore critical to ensuring that core course content and skills provision maps clearly to employer demand for skills and appropriately reflects the latest – and likely future – trends in the skills and knowledge needed in the jobs market.

6.34 Accreditation of degree programmes also has a significant role to play. As one of the more recognised mechanisms for facilitating HE provider and employer engagement, there is much opportunity within those systems to ensure that collaboration is meaningful and is contributing to reducing the apparent mismatch between the supply and demand for skills. More details on the review's conclusions on accreditation are set out below.

Improving STEM careers advice and graduate awareness of job opportunities

6.35 Careers advice, and student and graduate awareness of the opportunities that their degree might lead them to, has been an interesting theme throughout the review. Evidence from the review online stakeholder survey consistently highlighted that HE providers and employers felt that in some cases students and graduates were limiting their future potential employment outcomes through a lack of knowledge and awareness of the types of jobs roles that exist in the employment market and that relate to their degree programme.

6.36 Alongside this, evidence from the stakeholder survey and the focus groups suggested that many graduates could be doing more to engage at an earlier stage with thinking about their future career path and their HE provider's careers service. The review has not gathered, and is not aware of the existence of, quantitative data that would support these views. However, similar themes have arisen in the Shadbolt Review of Computer Sciences Degree Accreditation and Graduate Employability, with anecdotal evidence suggesting that despite a significant supply of work experience and other careers opportunities, students in many cases fail to engage and take up opportunities that are likely to help them develop the soft and work readiness skills that would help them to secure positive outcomes.

6.37 One of the challenges facing some graduates is that for a number of STEM disciplines, the potential careers paths on offer are often unclear. In many cases, this is a function of the existing relationship between many HE degree disciplines and industrial sectors, with many disciplines and industrial sectors not mapping onto each other. Advice about the opportunities available to graduates from their chosen discipline should be presented to students in some fashion that is easily assimilated before and throughout their course so that they have the widest vision of what is available. The destinations and careers of former graduates are often helpful guides to students in this respect.

6.38 The review, therefore, recommends that HE providers, with the full support and engagement of employers, should embed careers awareness and support within existing degree curricula to ensure that students engage with career choices throughout their degree and not just in their final year. Furthermore, students – including prospective students – should have better access to information on the graduate jobs market for their chosen degree programme and more broadly across STEM subjects, and be encouraged, and expected, to take greater responsibility for engaging with their future career path. Work experience is an important part of this and the review recognises that significant efforts are already being made to clearly articulate and communicate the benefits of work experience to students. This work needs to be supported and supplemented by additional efforts to improve the impact of existing communication with students so that, as a result, more of them go on to take up the opportunities on offer.

6.39 The review has also heard evidence to suggest that one potential barrier to graduates securing better employment outcomes is that some can lack the ability to articulate and exploit the soft skills that they do have and that they have developed

during their courses. The review believes that many graduates in this position would, therefore, benefit from additional careers support, guidance and coaching to help them more effectively recognise and then present their soft skills at, for example, interview and graduate assessment centres.

6.40 It has not been within the review's scope to consider the role of the STEM education 'pipeline' and early years and secondary learning. However, the importance of ensuring that young people are enabled to and are actively engaging with career planning throughout their education experience is a theme that has been raised at regular intervals with the review, with many stakeholders stressing the need for further work to be taken forward to explore and embed careers advice and planning earlier on in the educational pipeline. This represents a challenge that HE is not able – nor should it be expected – to tackle alone.

Recommendation 5 – Increased engagement between STEM employers and HE providers

Employers and HE providers should work more closely together in order to improve graduate employment outcomes. In particular, they should consider addressing the following areas:

- Improving the opportunities for students to take up work experience and to maintain its quality
- Embedding the development of soft skills into degree courses and improving work readiness
- Better matching degree courses to employer demand for skills
- Improving STEM careers advice and awareness of job opportunities for graduates and students, at school, college and HE

The data

6.41 The HESA graduate destination data has provided a useful source of information on graduate employment outcomes and this will be further enhanced by the availability of linked educational and employment record datasets that the Government expects to make available later this year. Also, data on what graduates do when they leave university or college is available from a range of both public and private organisations in the form of surveys and reports, many of which the review has attempted to reflect here.

6.42 The review acknowledges HESA's current review of destinations and outcomes data[40], which is due to report in Autumn 2016, and the wider Data Futures work being undertaken by HESA which aims to better consolidate data collection while reducing the burden on HEIs. It is acknowledged that it may be challenging to incorporate some of the recommendations that follow into the HESA destinations and outcomes review in the available timescales, but we recommend that this should be pursued as far as possible. It is anticipated that there is further scope for the recommendations to feed into HESA's Data Futures work.

40 https://www.hesa.ac.uk/pr/3686-review-of-data-on-destinations-and-outcomes-for-leavers-from-he

6.43 Gaining access to the range of available data, analysing and then presenting it for the benefit of a variety of audiences and purposes is not straightforward. To support efforts to develop a clearer understanding of graduate employment outcomes, more needs to be done to better integrate data sources and to ensure that they are opened up to be scrutinised by all. There are two specific areas where this review finds insufficiencies in data are holding back progress, in particular: **data on work experience that goes beyond the traditional one-year sandwich placements and detailed information on graduate outcomes.**

- A common language around work experience should be agreed and recommended for common use, to avoid ambiguity around terms such as internship, placement, industrial project. It is proposed that a group is convened to create an up to date set of terms that will be recognised and recorded more consistently, and thus enable better data comparisons in future. It is acknowledged that several informed organisations may wish to be involved in this task such as NCUB, the Association of Graduate Careers Advisory Services (AGCAS), accrediting bodies, the Association of Graduate Recruiters (AGR), HESA, the National Association of Student Employment Services (NASES), ASET.
- On work experience data the review recommends a number of activities:
  - Mapping where this data exists and any limitations on it (where the results of this exercise could usefully inform the HESA reviews as to any feasible extensions of their data capture). Care should be taken to differentiate accredited or credit-bearing types of work experience, where the expectation is that data about these experiences would offer greatest potential for inclusion into student data collections.
  - Promoting the use and visibility of the Higher Education Achievement Record (HEAR)[41], and more specifically the inclusion of work experience within it. It is anticipated that increasing student-led demand for the systematic capture of data on work experiences would incentivise investment in mechanisms to collect this information more broadly.
  - Developing a framework for better access to work experience data in future. It should aim for more granularity on take up of work experience across sectors, especially STEM disciplines, and to clarify the barriers to more students taking up work experience and to more, smaller employers offering opportunities.

6.44 Recommendations on embedding the use of consistent terminology (developed as a result of the first bullet under 6.43 above), and in relation to the recording of, and access to, data collected by the range of interested and informed organisations would be welcomed as a result of these activities. It is considered that an organisation such as NCUB would be an ideal lead for much of this work.

6.45 In terms of more detailed data on graduate outcomes, there are some questions raised by this review that appear fundamental to the employment outcomes, and

41 http://www.hear.ac.uk/

employability, of STEM graduates but, due to limitations in the current data, the review cannot provide a comprehensive interpretation. These questions include:

- Employer demand for STEM skills and for STEM graduates (including regional variations in demand). Throughout our investigations it has been challenging to identify robust evidence on the specifics of employer skills requirements across different types of industries, sectors and employer types. The review's scope has precluded it from seeking to explore these requirements in detail. Despite this, however, we have recognised the challenges associated with developing a clear understanding of the wider-ranging needs of employers across diverse sectors and industries with the lack of a national level framework for pulling this information together. We recognise that developing such a framework is likely to prove impractical and infeasible. Instead, we recommend that existing examples of industry and education providers working together within specific sectors and industries to identify skills gaps should be adopted as good practice more broadly across STEM industries and disciplines. The ABPI recently published a report on the extent and nature of the skills gaps in the Biopharmaceutical industry[42]. The Science Industry Partnership (SIP) is shortly due to publish a 10-year skills strategy[43] for the Life Sciences and Industrial Sciences sectors making recommendations for industry, education providers and Government. These provide good examples and models for how industry and education providers can collaborate to better understand the current and future skills needs of their workforces. We recommend that other sectors should be seeking to adopt similar proactive approaches to identifying their skills needs and that the findings of these types of activities should be shared more regularly to develop a more comprehensive picture of national level skills gaps. The NCUB should work together with the body that succeeds the UKCES to explore how to coordinate efforts.
- The mobility of UK-domiciled graduates from STEM disciplines; both into and between industries and occupations of employment (including those 'unrelated' to their original degree discipline), and into the global labour market (in particular, if – and how – UK-domiciled graduates take up employment abroad, and the extent to which this impacts on the observed domestic employment outcomes). The review recommends that these considerations are fed into the development of forthcoming work on linking HM Revenue and Customs data to graduate outcomes to help shape and refine what additional insights this data may be able to provide.
- The skills used by graduates in employment, including in relation to the nature of tasks undertaken by both the graduate and the organisation they work for. The review recommends that the HESA review of destinations and outcomes data explore alternative approaches with regard to a more responsive means of

42 http://www.abpi.org.uk/our-work/library/industry/Documents/Skills_Gap_Industry.pdf

43 http://www.scienceindustrypartnership.com/skills-strategy/

collecting data and information on the type and nature of graduate employment. This should include an articulation of graduates' skills use, including in relation to the skills and knowledge that their HE studies have equipped them with.

- A perception that the Office for National Statistics' (ONS) existing classifications of industries and occupations of employment have become unable to keep pace with the changing make-up of the UK's STEM workforce, and are therefore unable to facilitate meaningful analysis of graduate outcomes, has been supported by the review. With only minor revisions proposed for the 2020 update of the ONS's SOC2010[44], it is recommended that the Government include the review's finding in any response to the ONS consultation on revising the SOC2010.
- The relationship between students' prior attainment, degree outcome and subsequent employment outcomes as graduate leavers, and how this may differ across different STEM and other HE disciplines, is one that requires greater scrutiny and analysis using existing data. The Government and its agencies should seek to maximise the utility of existing student data collections and be proactive in terms making the results of such analysis available in a transparent and accessible format. Ideally, that analysis would extend beyond interrogation of HESA graduate destinations data to incorporate graduates' longer term skills development and career success in the labour market.

Recommendation 6 – Improvements to data on graduate employment outcomes

There are opportunities to enhance the richness, quality and consistency of data available on STEM graduate employment outcomes. Ideally it should be possible for analysis of student flows from particular HE disciplines into specific sectors of employment to better recognise the type of degree and reflect upon relevant features of their degree programme. Where appropriate this should align with HESA's existing work to review graduate destinations and outcomes data. It should also extend beyond student data collections with the ambition that information collected from employers and their representative bodies can be available for scrutiny in an accessible and comparable form.

44 http://www.ons.gov.uk/methodology/classificationsandstandards/standardoccupationalclassificationsoc

Accreditation

6.46 The review has gathered evidence which points to a positive link between graduate employment outcomes and those STEM disciplines that are subject to mature, longstanding systems of degree course accreditation. Evidence gathered has also indicated that, for some disciplines, there can be large variations in course content, even for courses with an identical or similar title, which can hinder industry's appreciation of the graduate skills and knowledge to be expected from particular programmes. This is particularly prevalent in the science disciplines. The review has heard positive comments on the impact of the Engineering Council's Accreditation of Higher Education Programmes (AHEP) framework for engineering disciplines.

6.47 In recommending a possible enhanced role for the Science Council, the review recognises that the requirement for Engineering is quite different from that of Science and that the Engineering Council therefore plays a very specific role in providing assurance that graduates have met the appropriate standards in circumstances where there are 22 discipline-specific engineering accrediting bodies. However, there are clear benefits in one coherent body acting to set common profession-wide standards and processes on behalf of a large group of disciplines that should have some resonance for the Sciences.

6.48 The review has received evidence that of all the current assurance measures in use for STEM courses within HE providers, accreditation is widely believed to be that which has the greatest positive influence upon employment outcomes. It seems likely that a coherent approach by Science towards getting the full value from this process, represented by a stronger co-ordinating remit for the Science Council, would have a positive effect on employment outcomes for students, HE providers, employers and the professional bodies.

6.49 Where it is possible to strengthen and develop greater coherence within existing accreditation systems, consideration should be given to how these remodelled systems could helpfully tackle some of the wider issues that the review has encountered. Remodelled accreditation systems could, for example, helpfully provide a framework for developing agreement between employers and the HE sector on common and consistent language around what is meant by 'work experience', 'soft skills' and how degree course titles map across to employment opportunities in industry.

6.50 The primary benefit of a stronger accreditation framework for the science disciplines would derive from its role as an important assurance mechanism, providing assurance that science degree courses have incorporated specific standards and, importantly, appropriate levels of industry engagement with course provision. Science disciplines have traditionally had less engagement with employers and industry compared to their engineering counterparts. A stronger system of accreditation for the science disciplines in this respect, coordinated by the Science Council, could provide an important assurance stamp that would confirm that a degree has been subject to the appropriate levels of industrial engagement and scrutiny.

6.51 The DLHE data on graduate employment outcomes indicates relatively few concerns with those disciplines that could be defined as sitting under the 'engineering'

umbrella. The engineering disciplines are subject to well-established systems of degree course accreditation and the principles of professional registration and registered professional status play important roles in setting clear standards and behaviours for the engineering professions. The review has observed that in a number of STEM areas, nascent systems of degree course accreditation are taking shape, and it is recommended that those systems embrace the learning and examples of good practice available through the engineering disciplines as well as those science disciplines – such as chemistry – where accreditation is already well-established.

Recommendation 7 – Accreditation

Good practice from existing, well-established systems of degree course accreditation should be highlighted and disseminated where it may be of interest to those STEM disciplines without an accreditation framework or where an accreditation framework is emerging. Potentially the Science Council should explore a future role in developing and overseeing a unified accreditation framework for the science disciplines that draws upon the experience of both the Engineering Council and those science disciplines where there are already well-established accreditation systems.

6.52 Many of the recommendations that we have set out here will require additional effort to take forward and we have been cognisant of this in setting out proposals. However, we have not sought to make judgements here on what form the resources required to take these pieces of work forward should take, or where the primary responsibility for those resources ought to reside. In some cases the work taken forward will reap benefits directly to various parties. For example, the coming together of HE providers and employers in IABs is to the benefit of both and therefore the decision on how that work should be taken forward should reside with those parties. It will be for those organisations and groups of stakeholders identified in the review as being the key owners of the actions we have recommended here to come to a view on how best to proceed and the extent and nature of any resourcing and funding implications.

References

ABPI (Association of the British Pharmaceutical Society) (2015) *Bridging the skills gap in the biopharmaceutical industry: Maintaining the UK's leading position in life sciences* (London: ABPI)

Atfield, G. and Purcell, K. (2010) *Job search strategies and employment preferences of higher education students*: Working Paper 2 (Manchester: HECSU)

Atfield, G. and Purcell, K. (2010) *The fit between graduate labour market supply and demand: Third year UK undergraduate degree final year students' perceptions of the skills they have to offer and the skills employers seek*: Working Paper 4 (Manchester: HECSU)

BCS (The Chartered Institute for IT) *Levels of accreditation* (www.bcs.org/category/7065 Accessed: 15/02/2016)

Berg, T. et al (2015) *Making co-op work for you: A comparative exploration of student attitudes to co-op programs in the United States and the United Kingdom Conference paper*: WACE 19th World Conference on Cooperative and Work Integrated Education, Kyoto, Japan

Bosworth, D. et al (2013) *The supply and demand for high level STEM skills: Technical report* (Wath-upon-Dearne: UKCES)

Bosworth, D. et al (2013) *The supply and demand for high level STEM skills: Evidence report 77 November 2013* (Wath-upon-Dearne: UKCES)

Buckley, A. (2015) *UK engagement survey 2015: Students: perceptions of skills development* (York: Higher Education Academy)

Bullough, T. and Taktak, D. (2015) *Pathways to success in engineering degrees and careers* (London: Royal Academy of Engineering)

CBI (Confederation of British Industry) (2011) *Building for growth: Business priorities for education and skills: Education and skills survey 2011* (London: CBI)

CBI (Confederation of British Industry) (2015) *Inspiring growth: CBI/Pearson education and skills survey 2015* (London: CBI)

Chatterton, P. and Rebbeck, G. (2015) *Report: Technology for employability: Study into the role of technology in developing student employability* (London: Jisc)

Crawford, C. and Greaves, E. (2015) *Socio-economic, ethnic and gender differences in HE participation*, BIS Research Paper No. 186 (London: BIS)

Dixon, M. (2015) The scale of 'leakage' of engineering graduates from starting work in engineering and its implications for public policy and UK manufacturing sectors: SKOPE Research Paper No. 122, January 2015 (Oxford: University of Oxford, Department of Education)

Docherty, D. and Fernandez, R. (2014) *Career portfolios and the labour market for graduates and postgraduates in the UK* (London: NCUB)

Docherty, D. and Fernandez, R. (2015) *Increasing the offer of work experience in STEM subjects: can demand match supply?* (London: NCUB)

Docherty, D., Jones, O. and Sileryte, I. (2015) *Growing experience: A review of undergraduate placements in computer science* (London: NCUB)

Docherty, D., King, J. and McKellar, Q. (2015) *Leading food 4.0: Growing university-business collaboration for the UK's food economy* (London: NCUB)

Engineering Council (2014) *The accreditation of higher education programmes (AHEP): UK Standard for Professional Engineering Competence: Third Edition* (London: Engineering Council)

Engineering Council (2014) *UK standard for professional engineering competence (UK-SPEC): Engineering Technician, Incorporated Engineer and Chartered Engineer Standard: Third Edition* (London: Engineering Council)

Fincher, S. and Finlay, J. (2016) *Computing graduate employability: sharing practice* (London: Council of Professors and Heads of Computing)

GCHQ (2015) *GCHQ certifies more Master's degrees in Cyber Security, News article - 29 June 2015* (www.gchq.gov.uk/press_and_media/news_and_features/Pages/GCHQ-certifies-more-Master's-degrees-in-Cyber-Security.aspx Accessed: 15/02/2016)

Government Office for Science (2010) *High-level skills for food: report from the Food Research Partnership skills sub-group* (Gov.UK)

Harrison, M. (2012) *Jobs and growth: the importance of engineering skills to the UK economy* (London: Royal Academy of Engineering)

HEBRG (Higher Education Better Regulation Group) (2011) *Professional, statutory and regulatory bodies: An explanation of their engagement with higher education* (London: Universities UK)

HECSU (Higher Education Careers Services Unit) (2013) *Learning from Futuretrack: The impact of work experiences on HE student outcomes*, BIS Research Paper No. 143 (London: BIS)

HECSU (Higher Education Careers Services Unit) (2015) *What do graduates do?* (Manchester: HECSU)

House of Lords (2012) *Higher education in Science, Technology, Engineering and Mathematics (STEM) subjects: Select Committee on Science and Technology: Select Committee on Science and Technology, 2nd Report of Session 2012-13* (London: The Stationery Office)

Hughes, T., Spong, S. and Sheen, J. (2014) *Attitudes and perceptions of careers in the agriculture and food sector* (London: NCUB)

IET (The Institute of Engineering and Technology) (2015) *Skills and demand in Industry: 2015 Survey* (Stevenage: IET)

IFST (Institute of Food Science and Technology) *How to apply for accreditation of a degree course* (http://www.ifst.org/accreditation-accreditation-degree-courses/how-apply-accreditation-degree-courseurse Accessed 11/02/2016)

Kelly, S. (2015) *Raising productivity by improving higher technical education: Tackling the Level 4 and Level 5 conundrum: Occasional Paper 11* (Oxford: HEPI)

Kumar, A., Randerson, N. and Johnson, E. (2015) *Engineering UK 2015: The state of engineering* (London: The Engineering and Technology Board)

Lowden, K., Hall, S., Elliot, D. and Lewin, J. (2011) *Employers' perceptions of the employability of skills of new graduates* (London: Edge Foundation)

Mathematical Societies (2015) *Submission to the Dowling Review* (London: The Council for the Mathematical Sciences)

Mellors-Bourne, R., Connor, H. and Jackson, C. (2011) *STEM Graduates in non-STEM jobs, BIS Research Paper No. 30* (London: BIS)

Mellors-Bourne, R. (2012) *CS graduate unemployment report 2012: An exploration of unemployment statistics within computer science graduate 'destinations' data* (London: Council of Professors and Heads of Computing)

Nesta (2015) *Analytical Britain: Securing the right skills for the data-driven economy: Policy briefing* (London: Nesta)

NUS (National Union of Students) (2015) *NUS commission on the future of work* (London: NUS)

Perkins, J. (2013) *Professor John Perkin's Review of engineering skills* (London: BIS)

Porter, A. (2014) *Student employability index 2014: Part one* (London: NCUB)

Porter, A. (2014) *Student employability index 2014: Part two* (London: NCUB)

Purcell, K. et al (2012) *Futuretrack Stage 4: Transitions into employment, further study and other outcomes* (Manchester: HECSU)

Rich, J. (2015) *Employability: Degrees of value: Occasional Paper 12* (Oxford: HEPI)

Roberts, G. (2002) *Set for success: The supply of people with science, technology, engineering and mathematics skills: The report of Sir Gareth Roberts' Review* (London: HM Treasury)

Science Council (2011) *The current and future UK science workforce* (London: Science Council)

SEPnet (South East Physics Network) (2015) *SEPnet Summer placements: Report on feedback from employers and students* (London: NCUB)

Smith, S., Smith, C. and Cadell, M. (2015) Can pay, should pay? Exploring employer and student perceptions of paid and unpaid placements in *Active Learning in Higher Education 16 (2) 149-164*

Stein, J. and Irvine, A.K. (2015) *Career preparedness and lifelong learning* (Salt Lake City, USA: Instructure)

Stowell, F. and Probert, S.K. (2013) *An investigation into opportunities and employability in the discipline of information systems on behalf of the Council of Information Systems Professors and the Higher Education Academy* (York: Higher Education Academy)

Tech Partnership (2015) *Datasheet: Tech graduates November 2015* (London: Tech Partnership)

Tech Partnership (2015) *Employer insights: skills survey 2015* (London: Tech Partnership)

Tech Partnership (2016) *Datasheet: Tech specialists in the UK* (London: Tech Partnership)

Toland, A. (2011) *HE STEM employability skills review: National HE STEM Programme* (Birmingham: National HE STEM Programme)

UKCES (2010) *Skills for jobs: Today and tomorrow: The national strategic skills audit for England 2010: Volume 1: Key findings* (Wath-upon-Dearne: UKCES)

UKCES (2010) *Skills for jobs: Today and tomorrow: The national strategic skills audit for England 2010: Volume 2: The evidence report* (Wath-upon-Dearne: UKCES)

UKCES (2011) *The youth inquiry: Employers' perspectives on tackling youth unemployment* (Wath-upon-Dearne: UKCES)

UKCES (2012) *The youth employment challenge* (Wath-upon-Dearne: UKCES)

UKCES (2013) *Scaling the youth employment challenge* (Wath-upon-Dearne: UKCES)

UKCES (2014) *UK Commission's employer skills survey 2013: UK results* (Wath-upon-Dearne: UKCES)

UKCES (2014) *Working futures 2012-2022: Evidence report 83 March 2014* (Wath-upon-Dearne: UKCES)

UKCES (2014) *Working futures 2012-2022: Introduction and commentary: Briefing paper May 2014* (Wath-upon-Dearne: UKCES)

UKCES (2014) *Working futures 2012-2022: Introduction and commentary: Technical report March 2014* (Wath-upon-Dearne: UKCES)

UKCES (2014) *Working futures 2012-2022: Introduction and commentary: Annexes March 2014* (Wath-upon-Dearne: UKCES)

UKCES (2015) High performance working: Segmentation of smaller workplaces (Wath-upon-Dearne: UKCES)

UKCES (2015) *Reviewing the requirement for high level STEM skills: Evidence report 94 July 2015* (Wath-upon-Dearne: UKCES)

UKCES (2015) S*ector insights: skills and performance challenges in the digital and creative sector: Evidence report 92 July 2015* (Wath-upon-Dearne: UKCES)

Universities UK (2015) *Supply and demand for higher level skills* (London: Universities UK)

University Alliance (2015) *Mind the gap: Engaging employers to secure the future of STEM in higher education (*London: University Alliance)

Wilson, T. (2012) *A review of business-university collaboration* (London: BIS)

Glossary of terms

ABHI	Association of British Healthcare Industries
ABPI	Association of the British Pharmaceutical Industry
ADS	Trade Association for the Aerospace, Defence, Security and Space sectors
AGCAS	Association of Graduate Careers Advisory Services
AGR	Association of Graduate Recruiters
AHEP	Accreditation of Higher Education Programmes
ASET	The Work Based Learning and Placement Learning Association
BBSRC	Biotechnology and Biological Sciences Research Council
BIS	Department for Business, Innovation and Skills
BME	Black and Minority Ethnic
CBI	Confederation of British Industry
CChem	Chartered Chemist
CEng	Chartered Engineer
Cogent	Employer-led skills body for the science industries
DfE	Department for Education
DLHE	Destinations of Leavers from Higher Education
EEF	Engineering Employers Federation
EMES	Earth, Marine and Environmental Sciences
EU	European Union
FEC	Further Education College
GSK	GlaxoSmithKline
HE	Higher Education
HEAR	Higher Education Achievement Report
HEBRG	Higher Education Better Regulation Group
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
HEPI	Higher Education Policy Institute
HESA	Higher Education Statistics Agency
IAB	Industrial Advisory Board
IAgrE	Institution of Agricultural Engineers
IChemE	Institution of Chemical Engineers
IED	Institution of Engineering Designers

IEng	Incorporated Engineer
IET	Institution of Engineering and Technology
IFST	Institute of Food Science and Technology
IMA	Institute of Mathematics and its Applications
IMechE	Institution of Mechanical Engineering
IoP	Institute of Physics
IPEM	Institute of Physics and Engineering in Medicine
JACS	Joint Academic Coding System
KIS	Key Information Sets
LDLHE	Longitudinal Destinations of Leavers from Higher Education
MEng	Master of Engineering
NASES	National Association of Student Employment Services
NCUB	National Centre for Universities and Business
ONS	Office for National Statistics
PG	Postgraduate
PSRB	Professional, Statutory and Regulatory Body
QAA	Quality Assurance Agency for Higher Education
RAS	Royal Aeronautical Society
RSC	Royal Society of Chemistry
SEMTA	Science, Engineering, Manufacturing and Technologies Alliance
SIC	Standard Industrial Classification
SIP	Science Industry Partnership
SIVS	Strategically Important and Vulnerable Subjects
SME	Small or Medium-sized Enterprise
SOC	Standard Occupational Classification
STEM	Science, Technology, Engineering, Mathematics
TEF	Teaching Excellence Framework
UKBIA	UK BioIndustry Association
UKCES	UK Commission for Employment and Skills
UKSPEC	UK Standard for Professional Engineering Competence
UUK	Universities UK
UWE	University of the West of England

Annex A

Wakeham Review Advisory Group membership

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David Barr	Science Council/Royal Society of Chemistry
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The Advisory Group met on the following dates:

13 April 2015

6 July 2015

1 September 2015

7 December 2015

12 January 2016