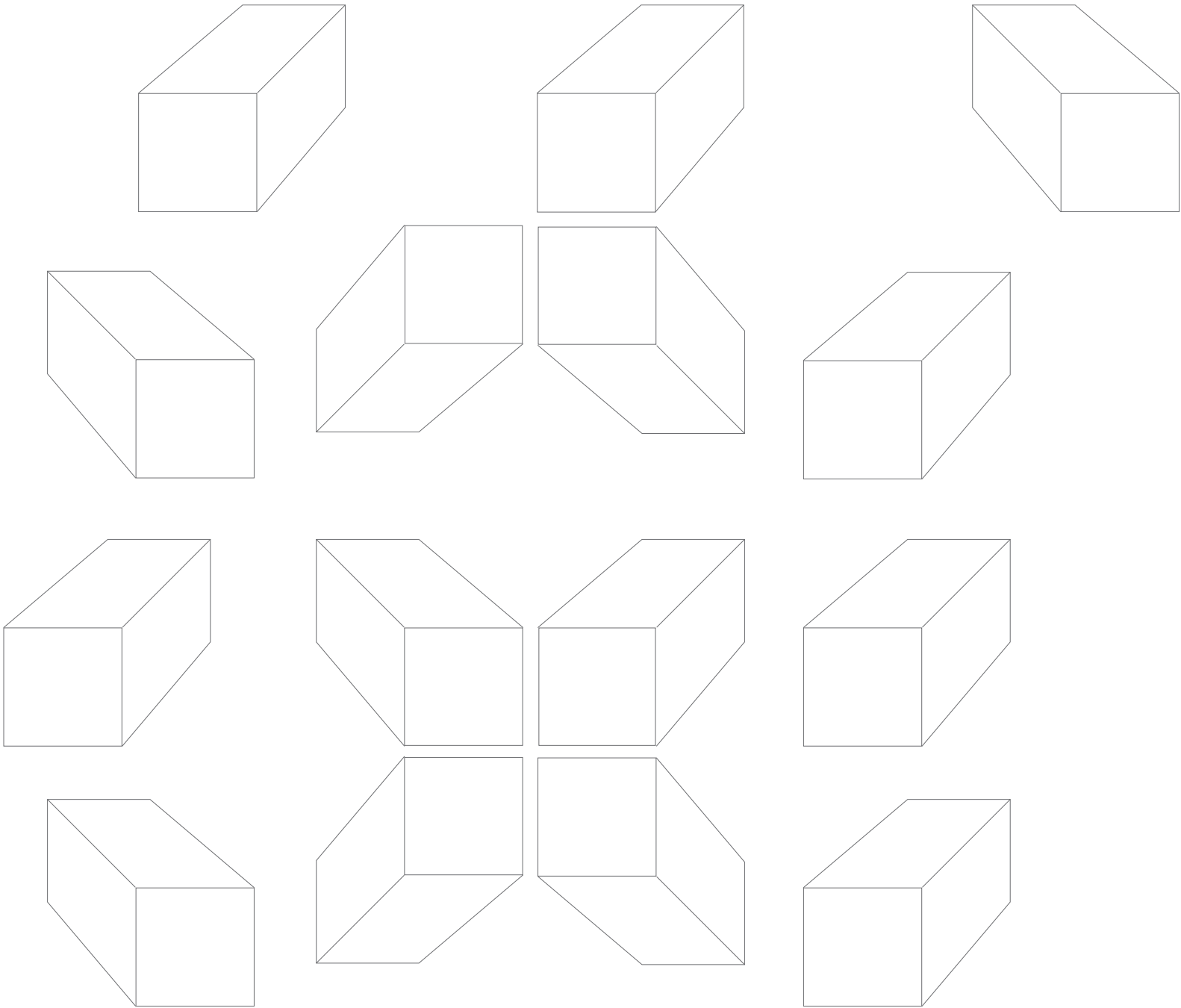
National HE STEM Programme

National HE STEM Programme Higher Level and Graduate Skills Development Projects: A Contextual Compendium

Jay Consulting (Jane Kettle and Judy Smith)



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UNIVERSITY OF BIRMINGHAM

STEM Education Centre

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About this document

In September 2011, the National HE STEM Programme identified six priority areas of activity for its final year of operation. One of these areas focused upon capturing the collective learning that emerged from the Programme and its projects in order that it might be further utilised by the higher education sector in the future. This report provides a background literature and policy review on employer engagement and employability developments in the Higher Education sector that will be useful to anyone seeking to undertake and embed curriculum innovations or enhancements in either of these areas. It is designed to complement the report "Lessons Learned and Achievements from the National HE STEM Programme Higher Level and Graduate Skills Development Projects". The National HE STEM Programme is grateful to the authors of this review for their hard work and dedication.

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Summary

This contextual compendium is designed to be read in conjunction with 'Lessons Learned and Achievements from the National HE STEM Programme Higher Level and Graduate Skills Development Projects', a report prepared by Jay Consulting on behalf of the National HE STEM Programme. The compendium articulates the aims and objectives of the HE STEM Legacy Projects and the Regional Action Plan Projects in the context of workforce development /life-long learning, and graduate skills. The compendium has four parts.

The introduction provides an explanation and context for the compendium. Section One provides a detailed account of policy development and Government interventions to address the way Higher Education Institutions (HEIs) approach employer engagement and workforce development. It explains how these have impacted on practical and strategic initiatives. Section Two addresses graduate skills, employability and enterprise and key issues in pedagogy. Section Three explores issues of student engagement and pedagogic practice that need to be considered in the context of higher levels skills and the National HE STEM Programme. The concluding part reviews the contemporary landscape for STEM and the higher level skills agenda. Throughout the compendium, emphasis is placed on the relevance of these initiatives and directives for STEM disciplines. This provides a background and context within which to review and reflect on the initiatives funded through the Legacy and Regional Action Plan Projects.

Introduction and context

Jay Consulting has produced a report relating to the Legacy and Regional Action Plan Project (RAPP) elements of the National Higher Education Science, Technology, Engineering, Maths (HE STEM) Programme. The report, 'Lessons Learned and Achievements from the National HE STEM Programme Higher Level and Graduate Skills Development Projects', provides a synthesis of the achievements of the National HE STEM activities concerned with higher level skills, workforce development and graduate skills developments in the STEM disciplines.

As part of the contextual work, a literature review was undertaken to provide evidence of and information about the policy and practice framework for the HE STEM Programme. This included that relating to higher education workforce developments, employer engagement and the demand for higher level skills including those specific to the STEM sector. It also encompassed the areas of graduate skills and employability issues and explored issues relating to students' engagement and the pedagogy of employer responsive provision. The contextual material is now presented as a compendium, a reference resource that should be used to supplement, inform and support the material presented in the Legacy demonstrator and the RAPP synthesis.

The HE STEM Programme supports higher education institutions (HEIs) in encouraging the exploration of new approaches to recruiting students and delivering programmes of study within the Science, Technology, Engineering and Mathematics (STEM) disciplines. The Programme encompasses a substantial number of national and local projects that align with the overarching National Strategy Framework. The Programme enables the transfer of best practice across the higher education STEM sector, facilitates its wider adoption, and encourages innovation. Through collaboration and shared working, it focuses on sustainable activities to achieve long-term impact within the HE sector.

The approach taken to deliver the work of the Programme has been designed to address directly the needs and priorities of higher education institutions and lead to sustainable outcomes in England and in Wales. The Programme has been managed through a 'hub and spoke 'model with project activity led by the central hub or through six 'spoke' institutions that have regionally focused activities. The University of Birmingham is the central hub for the national coordination of the programme as well as undertaking regional activities, with the Universities of Bath, Birmingham, Bradford, and ; Southampton; Swansea University and Manchester Metropolitan University managing regional projects.

The HE STEM Programme has been developed across three core strands of delivery that seek to deliver:

- activities to widen participation within and across the STEM disciplines at HE level working with schools
- HE curriculum developments focusing on course delivery and design, student support and knowledge and skills
- activities to encourage those currently within the workforce and society without a Level 4 qualification to engage in further study to develop enhanced knowledge and skills and to address the national higher level skills agenda.

This compendium considers activity that has primarily addressed the third strand relating to workforce development and higher level skills. It should be noted that in most cases activity impacts on the other strands.

The Programme overall intends that it should leave as its legacy a contribution towards enhanced knowledge of effective practices and approaches to initiating changes in policy, institutional management and teaching and learning practices across the Higher Education (HE) sector. This includes not only influence on curriculum and teaching and learning practices but also in relation to outreach activities and developing relationships and networks with a range of stakeholders. The specific work around Higher Level Skills and workforce development aimed to leave as a legacy a more flexible sector *better prepared* to meet the higher level STEM skills needs of the global workplace for the 21st Century[1]

The HE STEM Higher Level Skills sub-strands:

1. **Workforce Development and Lifelong Learning**
   Supports the higher education STEM sector in providing opportunities for those already in the workforce to develop enhanced knowledge and skills
2. **Graduate Skills**
   Supports institutions to work with employers to provide the necessary opportunities for undergraduate students to develop the range of knowledge, understanding, skills and competencies required to ensure they are adequately prepared for the workplace.

The objectives for the higher level skills element of the HE STEM Programme were to build on existing knowledge and experience of working with employers and develop new expertise within the STEM sectors for effective approaches to developing relationships with employers and employees. These objectives require partners to develop their own understanding of the issues and concerns around these topics.

1 National **HE STEM** Programme Strategy: 2010 – 2012 p20

Higher Level skills definition

Higher Level skills can be acquired through education, training and development which is all, or parts of, a degree, post graduate certificate, diploma, masters or doctorate. Equally, it can involve studying for an equivalent level professional or vocational qualification at Level 4 and above, perhaps through professional, industry or trade body, for example, continuing professional development courses in engineering, science or management. These higher level skills can be acquired through long, short, blended, work-based or distance learning without necessarily leading to qualification and can be offered in part or in full by universities, further education colleges, professional bodies, private providers and employer in-house training facilities.[2]

2 Cogent (2008) Technically Higher: Securing Skills For Science And Innovation, p8, http://www.cogent-ssc.com/Higher_level_skills/Publications/EmergingHigher.pdf

Section One: Workforce Development and Lifelong Learning

HEFCE (2011) in its Evaluation of the Higher Education Transforming Workforce Development Programme, carried out by KSA and CFE[3], offer a succinct explanation of the ways in which the concept of workforce development can be operationalised:

- it is a way of describing a wide range of learning-for-work activities and programmes (Jacobs 2002)[4]
- it refers to occupational preparation for employment, including basic, technical and academic competencies, rather than the higher level skills associated with university (Grubb et al, 1999)[5]
- it encompasses a range of services to facilitate those seeking and offering work access to a wide range of information about the labour market, education and training providers, skills standards and requirements and well as funding opportunities to take advantage of this (Martinson's 1999)[6]
- it may involve training but it also involves a range of other initiatives including work orientation, recruitment, mentoring, and crisis intervention. (Harrison and Weiss 1998)[7]
- there is a strategic link between workforce development, improvements in individual workers' performance and improvements at organisational level (Potter et al. 2003)[8].

3 HEFCE (2011) Evaluation of The Higher Education Transforming Workforce Development Programme, Report to HEFCE by CFE and KSA December 2011 http://www.hefce.ac.uk/media/hefce/content/pubs/indirreports/2011/re1311workforcedevprog/rd13_11.pdf

4 Jacobs, R. L. (2002) Understanding Workforce Development: Definition, Conceptual Boundaries, And Future Perspectives. International Conference On Technical And Vocational Education And Training (Canadian Vocational Association and UNEVOC), Canada

5 Grubb, W. N. and Associates (1999) Toward order from chaos. Berkeley, CA, National Centre for Research in Vocational Education.

6 Martinson, K. (1999) Literature Review On Service Coordination And Integration In The Welfare And Workforce Development Systems. Urban Institute

7 Harrison, B. & Weiss, M. (1998) Workforce Development Networks: Community-Based Organizations and Regional Alliances. Thousand Oaks, CA, SAGE Publications.

8 Potter, M. A. et al. (2001) A Model for Public Health Workforce Development using The National Public Health Performance Standards Program. Journal Of Public Health Management & Practice, 9(3).

Workforce development has been on the agenda of a number of HEIs certainly over the past 25 years, with universities working with employers to meet a variety of organisational requirements and challenges, including for example:

- increasing efficiency and productivity
- improving staff loyalty and retention
- addressing skills shortages
- talent management

As both a concept and an activity it opens up new opportunities for HE not least in considering the educational requirements for adult learners who may need to access and experience higher education in alternative ways from the dominant approach for full-time younger undergraduates. To be effective in workforce development HE providers also have to develop their own competences and experiences in engaging employers, responding to their needs and that of their employees.

Definitions of employer engagement and relationship to workforce development

The term employer engagement has been described as 'the process through which employers directly participate in activity facilitated by an external organisation in pursuit of shared objectives'[9]. In the HE context engagement is a relatively new term. It has also been subject to different interpretations, from the rather simplistic Higher Education for the Workforce[10], and knowledge transfer activities such as those supported by Higher Education Innovation Fund (HEIF) activity. The concept of employer engagement in HE has been quite problematic. One reason for this is the inherent tension between the use of commercial and academic language among the different stakeholders. The university emphasis is on promoting qualifications and credit recognition which are generally attractive to employees. Employer organisations however may be seeking more general business solutions which are often reactive and more closely aligned to training needs and improved employee and organisational efficiency[11].

Policy development and Government interventions

Although HEIs have for many years considered and experimented with developing provision to support Continuing Profession Development (CPD) generally

9 Sector Skills Development Agency (2007) Employer Engagement Guidance, Astrid Flowers Ltd & Simpson Consulting Ltd p3.

10 Wedgwood, M. (2008) Higher Education for the Workforce: Barriers And Facilitators To Employer Engagement DIUS Research Report 08 04, p8.

11 McDonald H (2008) *A Report on The Relevance of Language Barriers to Work Based Learning/Employer Engagement*, LSDA

at higher levels of learning, the interest in being more responsive to demand for workforce development at undergraduate level has been less enthusiastic. In the last decade there has, therefore, been a growing Government policy agenda about the issue designed to stimulate HE employer engagement.

Government drivers to encourage specific collaboration between employers and HEIs have mirrored the more general approach to workforce development but with some very specific interventions. Collaboration between HE and business had been an underlying theme in the Dearing Report of 1997[12] and became more explicit in subsequent Government reports. The Lambert Review (2003) recognised that there was much good collaboration relating to research, consultancy and knowledge transfer but HEIs were not generally well-practised in collaborating together to identify where they had areas of competitive strength and how they could work together with business to exploit their innovative ideas.[13] It called for closer working between HE and business particularly in the regions, an increase in the influence of sector skills councils on courses and curricula, being more responsive to the views of employers on funding HE programmes and improved work-placement opportunities for students. It recommended more CPD for employees but did not address skills mismatches to any great extent.

The subsequent Sainsbury Review of the Government's Science and Innovation Policies was more relevant to STEM and reinforced the Lambert message by stressing the importance of science and innovation in ensuring that the UK remained competitive in an increasingly globalised economy.[14] The imperative was to effect improved business and higher education collaborations for the application of science and innovations and indicated an impact on workforce development requirements. The Sainsbury Review informed the doubling of the number of Knowledge Transfer Partnerships (KTPs) and also shifted the economic impact of initiatives into a more influential measure for the funding of HE research.

It was the Leitch Review of 2006 which highlighted the need for considerable improvement in skills at intermediate and higher levels if the UK was to remain competitive globally. Leitch set ambitious targets for development by 2020 pointing out that almost 75% of the adult workforce of 2020 had already left compulsory education and many were already in employment[15]. This put a responsibility on HE providers to address their professional development needs by flexible means including through improved employer engagement. The Leitch report led to a number of Government directives on skills.[16] The UK Commission for Employment and Skills (UKCES) report *Ambition 2020: World Class Skills and Jobs for the UK* published in May 2009 considered the issue from another angle and suggested there was also a need for demand from employers rather than just policies designed to stimulate the supply. The UKCES proposed a new strategic framework to underpin 'thinking and action' on this area but with the new Coalition Government there has been less emphasis on this policy.[17]

Much of the workforce development provision by HEIs over the last ten years has been driven by this national skills agenda, in particular the Leitch targets, but there have been other imperatives. For example, one means to increase participation in HE is through vocational or work-based qualification routes, and increasing social diversity at certain HEIs was also a vehicle through which to address Government targets relating to social mobility improvement. In some cases, though, it was more local and regional, rather than national economic and skills agendas which encouraged HEIs to develop better employer responsiveness, especially for smaller companies operating locally or in niches. A significant development has been Foundation Degrees provision that have been designed to address work-force development in specific skills sectors and have work-based learning inherent in their curriculum design. These have generally also improved access to higher level learning for adult learners.[18]

A Royal Society report in 2008 into employer engagement reiterated the need for business- university collaboration around research and development but emphasized the importance of shifting this into the influence on teaching and learning developments.[19]

In response to the Government reviews a number of initiatives were launched by HEFCE to stimulate employer/HEI collaboration. These included the Higher Education Reach-out to Business and the Community (HEROBC) and the Higher Education Innovation Fund (HEIF). These were designed to encourage HEIs to establish the necessary infrastructure to

12 Dearing (1997) Higher Education in the Learning Society. The Report of the National Committee of Inquiry into Higher Education (The Dearing Report), available at www.leeds.ac.uk/educol/ncihe

13 HM Treasury (2003) Lambert Review of Business-University Collaboration: Final Report, 4 December 2003 http://www.hm-treasury.gov.uk/d/lambert_review_final_450.pdf

14 HM Treasury (2007) The Race to the Top A Review of Government's Science and Innovation Policies, Lord Sainsbury of Turville, October 2007 http://www.hm-treasury.gov.uk/d/sainsbury_review051007.pdf

15 DIUS (2007) Prosperity for All in the Global Economy - World Class Skills. Final report of the Leitch Review of Skills, 2006.

16 Department for Innovation Universities and Skills (DIUS) (2007) World Class Skills: Implementing The Leitch Review Of Skills In England. Sheffield: BIS; and, DIUS (2008) Higher Education At Work – High Skills: High Value. Sheffield: DIUS

17 UKCES(2009) Ambition 2020:World Class Skills And Jobs For The UK, May 2009 http://www.ukces.org.uk/publications/ambition2020

18 HEFCE(2010)Foundation degrees: Key Statistics 2001-02 To 2009-10 Issues Paper April 2012, P30

19 The Royal Society (2008) A Higher Degree of Concern, January 2008

be more business-facing, and provide business support for improving their innovation, enterprise and creativity and to begin to diversify in terms of the learning provision and services on offer.

In Wales the Welsh Government has set its own agenda for responding to requirements for higher level skills and enhanced business-higher education collaborations for workforce development. An early ESF funded Knowledge Exploitation Fund (KEF), gave some stimulus to the knowledge transfer activities between HEIs and businesses. The intention too was to link with Sector Skills Councils in developing high level skills training in science, engineering and technology and innovation management. The funding helped to identify specific training needs and gaps in provision, and develop innovative high level skills training for key industry sectors. This has led to supporting a Higher Education Funding Council for Wales (HEFCW) Third Mission Fund providing over £6m a year for HEIs to deliver services bringing economic and community benefits. Third Mission funding supports enterprise and entrepreneurship, including the development of spinout companies; training, consultancy and contract research services to business; and innovation and knowledge transfer.

This type of intervention did not have a significant impact especially relating to the provision of CPD within HEIs and a series of further commentaries and reports by interested stakeholders have emphasised the case for universities to work more closely with employers (see for example: Universities UK, 2008[20]; CIHE, 2007a[21]; CIHE, 2007b[22]; DIUS, 2008[23]).

Government drivers relating to STEM and employer engagement

The Roberts Review[24] was an early report that identified the need for improved business and university collaborations to influence the recruitment and retention of people with the skills demanded by employers in the STEM sectors. The Review focused on the supply of science and engineering skills in the UK. It stemmed from the Government's concern that the supply of high quality scientists and engineers should not constrain the UK's future research and development (R&D) and innovation performance. Although not specifically about employer engagement the report made a number of recommendations about involving employers in the higher education curriculum, the need for cross-university-business dialogue to give academics a broader understanding of STEM business sectors, and improvements in information about careers in the STEM sectors. The Government response was the development of the Higher Education Innovation Fund (HEIF) and the continuing outcome of this work has enhanced employer –university dialogue beyond R&D developments.

Significant/influential initiatives

Higher Level Skills Pathfinders

The two most significant initiatives relating to employer engagement and workforce development were instigated and funded by HEFCE. The first was the Higher Level Skills Pathfinder projects, launched in November 2006, in collaboration with the Department for Education and Skills. Three HLSPs were established altogether, in the North West, North East and South West regions as part of a broader employer engagement programme. The underpinning objective were to embed HE in employer workforce development and skills strategies regionally, sectorally and nationally and to embed workforce development and skills in HE providers' strategies, along with the previous Government's aim to promote greater co-funding of HE provision by employers. The HLSPs were also required to develop synergy in brokerage mechanisms, predominantly Train to Gain, to include diagnostics and signposting to relevant HE provision. The emphasis was on flexible lifelong learning and developing the capacity to deliver negotiated work-based learning, and in so doing to identify barriers to participation.

The then Government felt that the brokerage model was the best way of triggering and encouraging a system that was demanded and responsive to employer needs. The approaches adopted by the three HLSPs differed. The North West and the South West activity focused on sectoral activity when the North East followed an economy-wide approach. All three allocated funding for developing and trialling new approaches to workforce development and also created new courses and programmes. The intention behind the pathfinders was that they would contribute towards the development of a seamless skills service for employers by placing HE at the heart of the emerging infrastructures operating at regional level that enabled employers to access education and training provision to meet their identified workforce development needs.

20 CBI/UUK (2008) Stepping Higher: Workforce development through employer-higher education partnership

21 CIHE (2007a) Workforce Development: What works and why. Report for CIHE, Helen Connor, June 2007

22 CIHE (2007b) Workforce development: how much engagement do employers have with higher education? A review of the evidence on employer demand, Madeleine King for CIHE, March 2007

23 DIUS (2008) Higher Education at Work – High Skills: High Value. Sheffield: DIUS

24 HM Treasury (2002) Roberts Review SET for success: The supply of people with science, technology, engineering and mathematics skills ,Sir Gareth Roberts, April 2002

NW	NE	SW	SE	Midlands	National
Chester (2)	**Bradford***	Gloucestershire	Brighton	Anglia Ruskin	Cogent (Sector Skills Council)
Cumbria	Huddersfield	Harper Adams	Chichester	Aston	Open (2)
Liverpool John Moores	Northumbria	Harper Adams/Royal Agricultural College	East London	Bedfordshire	Skillset (SSC)
	Sheffield Hallam	Oxford Brookes	Hertfordshire (2)	Coventry (2)	
Salford	Teesside		Kingston	De Montfort	
	York		University of Arts London	Derby	
			London Higher (Lifelong Learning Network)	Leicester (2)	
			London WFD (LLN)	Staffordshire	
			Middlesex		
			South Bank		
			Southampton*		
			West London		

Table 1: List of HEFCE Funded Workforce Development projects by lead institution (HEI unless otherwise indicated)

*Also National HE STEM Programme Regional Spoke Lead institution

The 2008 formative evaluation of the HLSPs[25] recommended their continuation, citing that they were seen to be effective and articulating demand and addressing barriers to both identifying and addressing those demands. A particular strength was their inclusive, region-wide approaches, but the lack of engagement with SMEs was disappointing. The focus on brokerage, and its associated complexities, highlighted what was described in the evaluation as a crowded infrastructure, militating against the seamless journey that was hoped for. Their contribution to regional development made them a significant player and the RDAs were encouraged to support and endorse their continued engagement. There has been no subsequent roll out of the HLSPs nationally.

The HEFCE Employer Engagement programme

Probably the most significant initiative within the broader theme about the contribution that Higher Education makes to the higher skill development agenda is the HEFCE funded range of Employer Engagement projects across 39 HEIs, started in 2007, as part of its Workforce Development Programme. One of the key drivers was to encourage HEIs to develop provision that was more responsive to employers' needs, and for which employers would be prepared to pay up to 50% of the costs. So the central plank of the initiative was the introduction of a co-funding employer engagement model and the instigation of transformational change in employer engagement across the HE sector. Sixty million pounds was allocated to the projects, which had an eclectic mix of themes and priorities. Some of the projects were awarded to HEIs that were very experienced in the area, for others it was an entirely new venture. HEFCE simultaneously supported a range of complementary projects, including:

- projects focused on co-funding that were supported only by the allocation of additional student numbers
- the three regional Higher Level Skills Pathfinders referred to above (designed to enable HEIs to work together on employer responsive provision)
- a small number of 3rd Stream 2nd Mission projects (for those prepared to make business development a key part of their institutional strategy)
- regional Lifelong Learning Networks (which trialled collaborative vocational provision and cross-institutional credit frameworks)
- a set of Economic Challenge Investment Fund (ECIF) projects, designed to enable HEIs to support businesses in danger of shrinkage or collapse.

Overall £100M investment has been given to develop HE infrastructure for employer workforce development and create a platform for the longer term and this has involved ninety HEIs and FECs. The table below notes the distribution of these projects; aligned with the National HE STEM regions (this excludes Wales). Many of the institutions listed here also took part in the Regional Action Plan Programme, thus providing an opportunity for transfer of knowledge and understanding.

There was recognition at the early stage of the initiative that there were a series of challenges. Scaling up flexible activity to meet the specific needs of people who see themselves primarily as employees, and only secondarily, in support of their work, as learners in higher education, was going to present challenges to management systems and processes, as well as to

25 HEFCE (2008) Formative evaluation of the Higher Level Skills Pathfinders, Report to HEFCE by GHK, August 2008, http://www.hefce.ac.uk/pubs/rdreports/2008/rd14_08/

practice, and that more strategic approaches were going to need to be found. Pro-Vice-Chancellors were seen to be the key to such innovation at institutional level, HEFCE asked the Higher Education Academy (HEA) to facilitate a special interest group to explore these challenges. Responses to these challenges, together with exemplars and recommendations, were published in 2010[26].

The HEA also facilitated a network of project leaders who met regularly over a period of four years and who effectively formed a community of practice. This group contributed to the development of an understanding of the pedagogy of the initiative, and produced publications relating both to the quality assurance and quality enhancement of employer responsive provision, and to more general, thematic issues[27 28]. The key challenges projects identified included:

- The business case: how does this type of activity relate to the strategic priorities of the university and is it financially feasible?
- Scale: is this a peripheral activity or is it seen as a major function of the HEI?
- Cost: is the balance between cost and price one that will make fiscal sense?
- Management: where does this type of activity fit into HEI structures and what effect does this have on its operation?
- Location: where does responsibility for this operation lie- a devolved, hub and spoke or centralised model?
- Quality and standards: how does the provision sit within the university's general QA processes?
- Academic buy-in: does this activity have status and acknowledgment from discipline communities?
- Workforce and business planning: how is this aspect of university business incorporated into general CPD and other reward structures for staff?
- Staff competence: does the HEI have access to the necessary skills, knowledge and competence to undertake the work effectively?
- Administrative systems and facilities: are systems, processes and facilities sufficiently flexible to accommodate "non-traditional" provision?
- Marketing: how is the HEI's offer promoted, packaged and sold, to be accessible and attractive to a range of employers?

26 Higher Education Academy (HEA)(2010)University management of work-based learning , edited by Freda Tallantyre http://www.heacademy.ac.uk/assets/documents/employability/employeelearning/EEL_UniversityManagementOfWBL.pdf

27 HEA (2010) Quality and Responding to Employer needs , edited by Freda Tallantyre, Jane Kettle and Judy Smith, http://www.heacademy.ac.uk/flexible-learning,

28 HEA (2011) Learning from Experience in Employer Engagement, (2011), edited by Freda Tallantyre and Jane Kettle

The projects have now been evaluated[29]. Evidence suggests that regional agencies, sector skills councils, professional bodies and business organisations, have all made a clear commitment to this closer working and the positive impact that they believe this will bring. Impact includes:

- as a direct consequence of the Programme, HEIs now use a much wider range of business development and marketing interventions to systematically generate leads and secure new contracts
- HEIs have adapted their accreditation and quality assurance processes to be more appropriate for the demands of the employer market
- there is evidence of a emergent take-up of customer relationship management (CRM) systems to monitor interaction with employers and to enable a more joined-up approach across institutions
- there is evidence that HEIs involved in the Programme have become more business-like and professional in their approach to employers. This involves targeting their engagement activities more sharply, and focusing on high growth sectors with existing or well-developed contacts
- some HEIs have undergone transformational change, with some reorienting their mission to differentiate their offer in an increasingly competitive market
- HEIs have reviewed their capacity to respond more effectively to employers higher level workforce development needs, though the appointment of more appropriate staff, development opportunities for existing personnel with a focus on commercial awareness
- some HEIs have not found it easy to engage their academic staff
- the programme has promoted access to, and progress through, HE for a wide range of learners.

In the spring/summer of 2012, HEFCE invited the HEIs who had performed effectively in generating additional numbers through workforce development programmes to bid for a small amount of legacy funding and at the time of writing, arrangements for this were being finalised.

Developments in Wales

The Welsh Government with the Higher Education Funding Council for Wales (HEFCW) have developed a number of schemes in response to the Lambert report and the Leitch agenda with a particular remit for addressing higher level skills in Wales. The latter in particular has resulted in the development of the Wales Employment and Skills Board (in 2008) to

29 HEFCE (2011) Evaluation of The Higher Education Transforming Workforce Development Programme, Report to HEFCE by CFE and KSA December 2011

advise Government on employment and skills policies, with a remit to articulate the employer perspective. Initially there was a primary focus on the development of lower level skills but more recently following recommendations by the Commission for Employment and Skills there has been a growing interest in higher level skills both to promote demand from employers and influence the supply by HEIs.[30] In 2009, the Welsh Government published *For our Future – the 21st Century Higher Education Plan for Wales*, the review of HE provision in Wales and an action plan for further development. The plan acknowledged the role which HE plays in the social, cultural and economic development of Wales. It set out a range of expectations on social justice and support for the economy.[31]

HEFCW is responding to the requirements for higher levels skills workforce development and graduate employability development with financial support and direction to HEIs for employment-related Foundation Degrees (FD) in sectors of strategic importance to Wales, establishing national research centres, such as the National Science Academy, and expanding HE research capacity and the commercialisation of research. The Welsh Government Skills and Employment strategy and action plan recognised that STEM sectors are central to economic development. The ambition was set for the National Science Academy to improve the supply of scientists, technologists, engineers and mathematicians in Wales. This approach does parallel developments in England and the HE STEM projects in Wales come from this policy development.

For our Future also promoted the development of shorter learning programmes, bite sized accreditation and part-time learning opportunities. High-level workforce skills training and education is generally delivered part time and following a review of part-time provision by Graham in 200632 and subsequent research on supply and demand the Welsh Government has shown a continuing commitment to funding part-time provision to support workforce development as well as funds for employer engagement.33 Further, there is a growing interest in FDs in Wales (at a time when interest is waning in England) and a £16m ESF supported initiative commenced in 2009 and is ongoing for the promotion of FDs. A recommendation from the Wales HE Review has resulted in HEFCW funding regional collaborative approaches by HEIs to planning and delivery of employer responsive provision, to strengthen the interface between HE and the workplace. The intention is for more flexible provision.

Some of the key priority sectors for Wales reflect those of the UKTI discussed later and those relating to the STEM sectors include: [34]

Core or enabling sectors:

- Energy
- Environmental management
- Telecommunications and ICT

Strategically important sectors, considered as not necessarily enabling, but nevertheless of strategic importance to Wales:

- Bioscience
- Health
- Financial services/products and professional services
- Creative industries
- Automotive
- Aerospace

Identifying the priorities for workforce development in STEM sectors

It was important for the Legacy and RAPP STEM projects to develop an understanding how to undertake employer engagement and identify the need for workforce developments. The experience of other HEIs working in the field and the research reports referred to earlier could be drawn on to consider the best approach.

The programmes of study referred to are generally classed as Physical and Biological Sciences, Engineering and Technology, Mathematics and Computer Sciences but the associated employment sectors are not so easy to categorise and may also include businesses in a STEM related field. Some employers require core STEM competences in graduates achieved through specific disciplines while others require STEM related HE learning achieved through, for example, Subjects allied to Medicine, Architecture/Building, Psychology and Geography.[35] So understanding this range of businesses and what their requirements are can be challenging.

A DIUS report in 2008[36] suggested a typology of HEI–employer engagement that is based around four factors. These are:

30 Welsh Assembly Government (2008) Skills That Work for Wales A Skills and Employment Strategy and Action Plan, July 2008

31 Welsh Assembly Government (2009) For our Future – The 21st Century Higher Education Plan for Wales, Nov 2009

32 Department of Education, Lifelong Learning and Skills, (2006) The Learning Country 2: Vision into Action, Cardiff: Welsh Assembly Government

33 Williams G (2010) Research into Part-time Higher Education Supply and Demand, WAG, Social research Number: 08/2010 http://dera.ioe.ac.uk/13166/1/110602parttimehighereducationresearchen.pdf

34 Welsh Assembly Government(2008) Skills That Work for Wales A Skills and Employment Strategy and Action Plan, July 2008, P 58

35 BIS (2011) STEM graduates in non-STEM jobs, BIS Research Paper number 31 March 2011

36 DIUS (2008) Higher Education for the Workforce: Barriers and Facilitators to Employer Engagement, DIUS Research Report 08

- geographical – local, regional, national, and/or international;
- employer type – old/mature, new/ growing industries, SMEs;
- scope of links – labour supply, CPD, R&D, partnership/networks; and
- the extent to which links are systematic – formal links as opposed to more ad hoc arrangements.

Together these various dimensions raise the concern that any HEI aiming to address employer engagement in the STEM field is entering a complex arena and choices need to be made in how the issue is to be approached.

The South West Higher Level Skills Pathfinder undertook a literature review to identify employer demand for higher level skills and this provided good background information for STEM projects to build on. Regional Skills Partnerships, Sector Skills Councils and Professional bodies have also provided a number of commentaries relating to specific elements and requirements for skills and graduate attributes in targeted areas. Not least has been a plethora of guidance on demand in the green industries and support for low carbon initiatives. (see Bibliography for examples).

Professional bodies and Sector Skills Councils can act as brokers for HEIs in dealing with employers as well as provide access to data on skills gaps and where the demands are, particularly with smaller sized businesses. The Wilson Business-University Collaboration Review considered two aspects to building relationships with employers that provide food for thought. One think-piece considered HEI engagement with Small andMedium-sized Employers (SMEs). Developing relationships to enhance placement opportunities, internships, projects and consultancy was seen as beneficial.

To expand these dimensions of collaboration requires efficient and effective connectivity[37]

A further think-piece considered the role of Sector Skills Councils[38]. Here there is a shift away from consideration of SSCs acting as intermediaries between HEIs and employers toward a role in developing integrated, work experience, placements, internships, in embedded work-based learning and enhanced student employer engagement and especially through greater involvement with the HE curriculum. Wilson encouraged SSCs to have an action plan relating to HE.

Where are we now?

The previous studies have shown that the market demand by employers may vary. An important lesson for any universities engaging with employers is to develop sensitivity about the priority areas for employers and to consider the wider propositions around engagement with a university. The UK's workforce has changed rapidly over the last 25 years and there has been what is described as a move towards a "knowledge economy". The outgoing Labour Government in 2010 had acknowledged that in a knowledge economy, universities are the key to generating and transforming knowledge into wider social and economic benefits[39]. This concept has coined the phrase "high performance working". This more holistic approach to workforce development is characterised by more complex job design, greater use of team working and more devolved lines of responsibility. It can lead to demands for better organisational leadership, wider employee skill sets, and less distinction between formal and informal learning at work.[40] However, the near collapse of financial and banking systems across the world has resulted in severe cuts to HE. That, combined with the new funding regime to be introduced in 2012, places the relationships for learning firmly between the learner and the HEI. The former Government kept employer engagement on the agenda in a chapter of its own, as well as dispersing it through all other chapters by emphasising the economic impact of HE through teaching, research, curriculum and civic engagement. It also proposed a reorientation of the curriculum towards those subjects seen to be most relevant to the economy, and in particular STEM disciplines. How this will be taken forward in the new landscape is not certain.

The recent Review of University-Business Collaboration by Wilson has reinforced the need for stronger relationships between business and higher education. Wilson provides a more sophisticated summary of business- university relationships and suggests these consist of a number of diverse domains[41]

One dimension relates to the source for the engagement including for example:

- applied research in advanced technologies
- in-company up-skilling of employees
- bespoke collaborative degree programmes
- science park developments
- enterprise education
- entrepreneurial support for staff and students
- higher-level apprenticeships
- skills development of post doctoral staff.

37 BIS (2012) A Review of Business–University Collaboration, Professor Sir Tim Wilson DL, Thinkpiece on SME connectivity , http://www.wilsonreview.co.uk/review/

38 BIS (2012) A Review of Business–University Collaboration, Professor Sir Tim Wilson DL, Thinkpiece: the role of Sector Skills Councils in HE programme accreditation

39 BIS (2009) Higher Ambitions: The Future of Universities in a Knowledge Economy. London: BIS

40 Brennan, J. et al. (2006) Towards a Strategy for Workplace Learning: Report to HEFCE. London: CHERI and KPMG

41 BIS (2012) A Review of Business–University Collaboration, Professor Sir Tim Wilson DL, February 2012 http://www.wilsonreview.co.uk/review/

A second dimension of each domain is defined by industry sector—for example, the creative industries, agriculture, bio-pharma or engineering.

'Universities operate in specific domains, meeting the needs of a range of businesses; no one university can operate in all domains.'[42]

Between 2003/4 and 2010/11, HEIs increased their income derived from providing courses for business, both commercial and not-for-profit, by 77%[43]. Overall universities earned over £1 billion through contracts with business in 2010-11. The commercial viability of such activity may be a strong driver in some institutions in the new financial landscape.

Summary of some of the key issues relating to employer engagement and collaboration

Understanding the market:

- The market is highly variable- there is no one group of employers. Market segmentation is complex and varies according to the sector, the size, capability of the business and the economic climate
- Public and private sector employers have different needs, demands and priorities in accordance with source of funding and ability to generate funds for continuing developments
- Some employers have a greater or lesser interest and investment in local, regional, national and international business
- For some employers improving the skills base and flexibility of the workforce at all levels is crucial in underpinning the UK's competitiveness particularly against lower wage cost countries
- Businesses themselves may choose which domain to operate in and may collaborate with one or more universities in order to meet their own needs – which may include stimulating competiveness amongst higher education providers
- The supply chain for major employers may be a source of further developments for HEIs

Understanding the demand for learning

- Approaches to HR and staff development varies
- Employers and employees may differ in the perception of need for higher levels skills and workforce development
- Employers have an interest in enabling all staff to contribute to business performance according to their ability
- Learning for the workplace can be integrated with learning in the workplace
- Continuous Professional Development, sector skill developments and requirements for compliance may influence priorities for learning
- Combination of vocational/occupational technical and academic knowledge and skills may be required

Understanding the needs of businesses

- The priority of the employer is the business and the performance of the business
- HEIs have to understand the dynamism of the business and itself be business-like and commercial
- Learning and training is understood in terms of the value proposition for the business and should be approached in a similar vein so any recruitment, training, development and staff retention relates to this
- Costs of investment for employers have to be understood and explicit
- The changing demands within business requires a flexibility in how employees will gain access to learning and business models and processes need to be flexible in developing the supply of the learning
- The need for understanding the challenges of the working environment, business and commercial awareness
- Recruitment, retention and performance of staff may be rewarded through the provision of access to awards that provide incentive, recognition and career progression
- Learning provision does not need to be accredited however for this to be recognised internally within a business

Understanding why employers want to engage with HEIs

- Employers want access to graduates for recruitment. This may reflect local, regional national and international demand
- Access to the accreditation of learning (including prior learning) through the HE quality assurance process, whether in the workplace or at the HEI, combined with assuring subject discipline standards. This assures quality for the employer and provides the employee with an HE award. For both, it provides credibility and recognition
- For CPD and accredited HE learning for career progression and industry compliance where links tend to be local because employees need to be close to the university at which they were studying
- Research and development – especially collaborative research and contract research
- Opportunities for under-graduates and post-graduates to be involved in projects to support business needs
- Employers in new industries and sectors want to link with HEIs to develop understanding through research, synthesis and analysis, the nature

42 Ibid p1

43 HESA (2012) HE Business and Community Interaction survey 2010/11

of new professional areas, their knowledge and skills needs and how to meet them

- For enhanced knowledge of the discipline and inter-disciplinary developments
- Employers want to be collaborate with HEIs on particular projects and activities that are mutually dependent and beneficial
- Access to Facilities and equipment
- Consultancy

Improving practice in employer engagement

In the evaluation of the HEFCE funded employer engagement projects CFE/KSA noted that projects have identified ways to improve relations with businesses. These can be lessons for other HEIs to draw on:

- using a much wider range of business development and marketing interventions to systematically generate leads and secure new contracts
- implementing systems and processes to refer and respond to employer enquiries and leads
- systematically maintaining contact with existing and previous clients, identifying and targeting warm employer leads, working with industry networks and following up recommendations from business support organisations, clients or partners
- adapting accreditation and quality assurance processes to align with the demands of the employer market; and to accelerate validation, APEL and shell frameworks.
- use of CRM systems to both track interaction with employers and support a more joined-up approach across institutions
- adapting student record systems to accommodate non-traditional learners
- becoming more business-like and professional in their approach to employers
- changing modes of delivery to meet new markets through distance, work-based and blended learning
- targeting promotion, lead generation and engagement activities, and focusing marketing at high growth sectors
- recognising both the commercial risks of relying exclusively on relationships with a small number of larger organisations and the need to work with, and through, sector and employer bodies to aggregate demand from SMEs. HEIs also recognise that more can be done to access demand from the supply chains of their larger employer clients

Section Two: Graduate Skills

Definitions of graduate skills

The policy focus on graduate skills has inevitably increased due to the changing economic downturn but also because of the increasing competition to employ graduates with requisite skills and knowledge by globally based companies. The agendas of the current coalition and previous Governments for Higher Education as outlined in '*Higher Ambitions*'[44] and '*Students at the heart of the system*' [45] emphasised the importance of graduate skills and the need for HEIs to improve collaboration with employers to inform the curriculum and help development student skills.

HEFCE requires English HEIs to improve information for students on employability and through the widening access initiatives to support student employment outcome. This has resulted in a change in internal HEI missions toward supporting and enhancing graduate employability. The Welsh Government have been establishing and strengthening a national employability programme, Go Wales, that supports graduate career management with work placement and experience opportunities. The programme is supportive too of the widening participation agenda. The HEFCW Skills and Employability Framework Action Plan has resulted in a recent partnership of key organisations from across the HE sector, from Higher Education Wales (HEW), Higher Education Funding Council for Wales (HEFCW), and NUS Wales, with CBI Wales to increase the employability of graduates in Wales. The partnership aims to:

- increase the number of high-level work placements, including providing opportunities through schemes such as GO Wales, Jobs Growth Wales and for science undergraduates via Techniquest's schools outreach programme
- increase the availability of courses in higher education endorsed by employers through engagement with skills and business representative bodies during curriculum development; and
- make available more employability and entrepreneurship modules and opportunities for students in universities.[46]

The aim of the HE STEM Programme is to enhance graduate skills for employment and raise awareness of the skills developments within the programme. This is part of a much wider focus on "employability", of which graduate skills are an element. The programme allowed some of the projects to build on existing approaches in their HEIs and/or develop something new in the STEM disciplines.

What constitutes employability and which graduate skills or attributes are required is contentious. Some HEIs argue it is not the place of a university to develop skills for employment: the approach is instrumentalist and universities are not training providers.[47] Others recognise however that HEIs do have a role to play in encouraging students in the development of the skills and attributes. The HE STEM programme is designed to address some of these issues at a local level.

When employers look to recruit HE graduates there is an expectation that those leaving HE will have the knowledge, skills and competences that will prove beneficial in the workplace. Some contemporary observers such as Redmond[48] argue that securing employment is not enough for graduates. More importantly in a rapidly changing employment and global economic context is being able to secure and successfully maintain employment, progress in the world of work and through self-sufficiency manage a career through enhanced employability. Therefore all HE programmes should endeavour to develop a model of employability that facilitates not only subject knowledge but also self-management and career building skills alongside opportunities to enhance employability.

Dacre Pool and Sewell from the Centre of Employability, University of Central Lancashire, define employability as

'Employability is having a set of skills, knowledge, understanding and personal attributes that make a person more likely to choose and secure occupations in which they can be satisfied and successful'[49]

The HE STEM programme is concerned with graduate skills, higher level skills development and lifelong learning. This report considers the connection between these different elements in relation to employability without stressing this unnecessarily. The definition of employability of the Enhancing Student Employability Co-ordination Team (ESECT) and widely adopted in the UK is:

44 BIS(2009) Higher Ambitions, The future of universities in the knowledge economy, www.bis.gov.uk/wp-content/uploads/.../Higher-Ambitions.pdf

45 BIS (2011) Students at the Heart of the System, http://bis.gov.uk/assets/biscore/higher-education/docs/h/11-944-higher-education-students-at-heart-of-system.pdf

46 HEFCW: Skills and employability framework: Agreement on skills and employability for Wales, June 2012 http://www.hefcw.ac.uk/policy_areas/business_and_communities/skills_employability.aspx

47 See for example http://www.lrb.co.uk/v33/n24/keith-thomas/universities-under-attack

48 Higher Education Careers services Unit (2011) Research report: Graduate Market Trends Autumn 2011, pp4-7 http://www.hecsu.ac.uk/research_reports_graduate_market_trends_autumn_2011.htm (accessed 21/02/2012)

49 Dacre Pool L, Sewell P, (2007)The key to employability: developing a practical model of graduate employability, Education and Training, Vol 49, no 4 pp277-289, Emerald

a set of achievements, skills, understandings and personal attributes that make graduates more likely to gain employment and be successful in their chosen occupation[50]

This definition opens up the concept of employability to include those who graduate from HE and also includes those already in work who are aware that further skills, competences and attributes will be developed in the workplace which will make them more likely to maintain employment. The HE STEM programme has a focus on workforce development which may be on up-skilling staff who are entering HE level study or for those already in the workplace who may be looking for further development at undergraduate or post-graduate levels and are therefore on a lifelong learning programme. With an increasing emphasis on new technologies in the STEM sectors and changing economic requirements for UK businesses, the requirement to up-skill and/or reskill and to have a strong ability to utilise skills and knowledge more effectively for what is often described as "high performance working" is become more relevant.

There is a growing policy agenda in the skills arena for people to develop the right skills for business performance not just to have additional skills and qualification and that those with more experience develop improved management, leadership and job design within the workplace.[51] The CBI definition of employability skills brought these two elements together:

'A set of attributes, skills and knowledge that ***all labour market participants*** *should possess to ensure they have the capability of being effective in the workplace – to the benefit of themselves, their employer and the wider economy'*.[52] [author's emphasis]

Many HEIs are now adopting a renewed focus on the student experience and in engaging students as partners in learning. The challenge for HEIs is to address this through enhancing the quality of pedagogical approaches: the context of delivery, curricula construction and recognition of the impact that co-curricular and extra-curricular activities have in encouraging students to become confident learners and individuals capable of making a full contribution to society.

The CBI list of employability skills includes

- self-management
- team-working
- business and customer awareness
- problem solving
- communication and literacy
- application of numeracy
- application of information technology
- entrepreneurship/enterprise
- underpinning all these attributes, the key foundation, must be a positive attitude: a 'can-do' approach, a readiness to take part and contribute, openness to new ideas and a drive to make these happen.[53]

Evidence shows the majority of employers are happy that graduates demonstrate most of these skills, for example in a recent Institute of Directors Survey[54], but there are concerns that students have less understanding of the world of work and business needs. A research report by SCRE Centre for EDGE, notes that although a range of organisations have contributed to the debate on graduate skills and have classified the skills in a variety of ways nevertheless there is general agreement on the qualities characteristics and skills that constitute employability.[55]

A Pedagogy for employability

In developing the curriculum, skills development and the subject studied are inter-related. In many HEIs it is accepted that the subject benchmarks, as developed by the Quality Assurance Agency (QAA), provide ample opportunity for students and academics to understand how skills development is integrated within subject knowledge. The HEA/CIHE subject employability profiles are useful to identify these within all subjects and are in synchronisation with QAA benchmarks.[56]

Approaches to teaching and learning in the delivery of the curriculum, ensure that skills such as critical analysis, synthesis and problem-based learning are central components and students require skills in presentation and team working in order to achieve learning outcomes. These are all skills that are required in the workplace. This view of employability links such skills requirements within the general attributes a graduate leaves HE with. Barrie defines graduate attributes as being '*the skills, knowledge and abilities of university graduates, beyond disciplinary content knowledge, which are applicable*

50 HEA (2006) Pedagogy for employability. Learning and Employability Series One. York: ESECT and HEA. Available from:http://www.heacademy.ac.uk/assets/York/documents/ourwork/employability/id383_pedagogy_for_employability_357.pdf

51 UKCES (2010) High Performance Working, A policy review, http://www.ukces.org.uk/publications/er18-a-policy-review

52 CBI /UUK (2009) Future fit: Preparing graduates for the world of work, p8http://www.universitiesuk.ac.uk/Publications/Pages/Futurefit.aspx

53 Ibid, p8

54 Institute of Directors (2007) Graduates' employability skills, Skills briefing December 2007: http://www.iod.com/MainWebSite/Resources/Document/policy_paper_graduates_employability_skills.pdf

55 Lowden K, Hall S, Elliot D, Lewin J (2011) Employers' perceptions of the employability skills of new graduates, Research commissioned by the Edge Foundation, University of Glasgow SCRE Centre

56 QAA Subject Benchmarks http://www.qaa.ac.uk/ASSURINGSTANDARDSANDQUALITY/SUBJECT-GUIDANCE/Pages/Subject-benchmark-statements.aspx

to a range of contexts'[57] This has been explored by the Scottish Quality Enhancement Theme which addresses links between Graduate attributes and Research.

'The 'attributes' in question are the high-level generic attributes that are necessary to allow our graduates to contribute to and thrive in a super-complex and uncertain future where the ability to question, collate, present and make judgements, quite often with limited or unknown information, is increasingly important'[58]

Such attributes include:

- critical understanding
- subject/discipline knowledge
- an awareness of the provisional nature of knowledge, how knowledge is created, advanced and renewed, and the excitement of changing knowledge
- the ability to identify and analyse problems and issues and to formulate, evaluate and apply evidence based solutions and arguments
- an ability to apply a systematic and critical assessment of complex problems and issues;
- an ability to deploy techniques of analysis and enquiry
- familiarity with advanced techniques and skills; Originality and creativity in formulating, evaluating and applying evidence-based solutions and arguments
- an understanding of the need for a high level of ethical, social, cultural, environmental and wider professional conduct.

The recent HEA edition of Pedagogy for Employability makes clear that '*employability is not about lists or categories of skills, and when we refer to employability ……this refers to both "skilful practices in context" ……and an approach to personal development and career planning that is included within the notion of employability*'.[59] This reflects a growing requirement to consider the development of employability in HE associated with curriculum development as proposed by the original ESECT team. Approaches can vary:

- employability through the whole curriculum
- employability in the core curriculum
- work-based or work-related learning incorporated as one or more components within the curriculum.
- employability-related module(s) within the curriculum
- work-based or work-related learning in parallel with the curriculum

The UK Commission for Employment and Skills (UKCES), in '*The Employability Challenge*'[60] developed a framework for the skills it considers important to employability and this reflects the inter-related aspects of employability development.

'In broad outline, developing employability skills entails:

- *experiential action-learning: using skills rather than simply acquiring knowledge;*
- *placing emphasis on trial and error, and with a clear focus on the pay-offs for the learner in employment and progression;*
- *work experience: a work placement in an actual business, or an authentic classroom simulation based on a real workplace;*
- *opportunities for reflection and integration.'*[61]

There is growing interest on co-curriculum activities such as through work-placements and internships in order to give students direct contact with employers and work experiences. The recent Wilson report highlights the need to strengthen the opportunities for internships and placements and there continues to be a growing demand for an increase in sandwich placements. The STEM disciplines are more familiar with these approaches.

Sandwich degrees should be encouraged through a new compact between students, universities, government and employers, reflecting the benefits to all parties from the enhanced employment outcomes arising from them[62].

The context for the development of more effective work placements comes from the whole 'student experience' policy arena as outlined in the Government White Paper *Students at the heart of the system*. Here the aim is for an institution to provide enhancements to the core study programme to provide a student with additional experiences and opportunities that will give them an individual edge as they move into careers and further study. The activity is seen as complementary to classroom learning although it takes place out of subject curriculum area and can be wrapped together into a university Award scheme that receives accreditation and can be an addition or part of the student's record of achievement in the university.

57 Barrie S.C. (2007). A conceptual framework for the teaching and learning of graduate attributes. Studies in Higher Education 32(4) 439-458. http://www.itl.usyd.edu.au/aboutus/SHE_2007_A%20Conceptual%20framework%20for%20the%20teacing%20and%20learning%20of%20GGA.pdf

58 Jenkins, A (2009) Research-Teaching Linkages: enhancing graduate attributes. Overview: the aims, achievements and challenges from the Enhancement Theme, QAA, Foreword http://www.enhancementthemes.ac.uk/documents/ResearchTeaching/SectorWideDisc_vol1_final.pdf

59 HEA(2012) Pedagogy for Employability, An update by Ann Pegg, Jeff Waldock, Sonia Hendy-Isaac, Ruth Lawton

60 UK Commission for Employment and Skills (2009) The Employability Challenge. Full Report. London: UKCES.

61 Ibid, p5

62 BIS (2012) A Review of Business–University Collaboration, Professor Sir Tim Wilson; Section 4 http://www.wilsonreview.co.uk/review/

Funding has been available to develop some different models of placements and internships and an evaluation of these can be found in the Oakleigh report.[63]

The 1994 group in a 2009 publication' Beyond the Curriculum' defined co-curricular activity as *clustering together the following: a) structured programmes of activity leading to a university award, which may include receiving university credit; or b) university-facilitated programmes of events which do not lead to an award, but can be useful to enhance the student experience and employability*[64]

There is a need for further evaluation of the benefits of these types of experiences as the evidence on outcomes is rather thin on the ground. It is imperative that placements are made more effective in providing good learning experiences and these require them to be formalised and well organised. This involves time and resourcing costs and also a strategic commitment to developing methods for learner involvement and reflection. Also how the placement should be framed, the time required for effective experiences, how the placement fits with the whole learning experience and can be used for the rest of the degree programme and so forth requires thought. There is little evidence of what the optimum elements for these are but there placements can be effective in improving degree.

Graduate skills, employability and STEM: the context

Graduate skills development in the STEM sectors includes a strong focus on providing opportunities for core skills development plus some of the softer skills employers identify that they need. There is also a requirement to ensure that HE STEM programmes are delivering programme content and knowledge that reflects the demands for innovations that are required in the national and international STEM employment sectors. The recent House of Lords Select Committee report Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects reiterated previous summaries of the characteristics of a STEM graduate including: '*numeracy and the ability to generate, understand and analyse empirical data including critical analysis; an understanding of scientific and mathematical principles; the ability to apply a systematic and critical assessment of complex problems with an emphasis on solving them and applying the theoretical knowledge of the subject to practical problems; the ability to communicate scientific issues to stakeholders and others; ingenuity, logical reasoning and practical intelligence.*'[65]

There is however evidence of tension about issues of supply and demand of graduates with relevant skills to meet employer needs.

The Roberts Review of 2002 investigated the supply of candidates with science, technology, mathematics and engineering skills[66] and noted that generic employability skills were as equally relevant to employers as specific technical skills developed through a particular discipline. The 2009 BIS report *The demand for Science, Technology, Engineering and Mathematics (STEM) Skills* noted employers concerns in recruiting to particular areas of the biosciences, engineering and IT, mainly related to the lack of applicants with specific STEM knowledge and qualifications but also about the lack of candidates with technical skills, broader competencies, mathematical capability and practical work experience.[67] The HEFCE report into Strategically Important and Vulnerable Subjects reported that employers consistently identify a demand for STEM graduates, which arises from a broad requirement for numeracy aligned with specific technical skills and that, employers are concerned about broad employability skills[68]. There is also evidence that many STEM graduates enter non-STEM jobs because their skills in numeracy, analysis and problem-solving, as well as technical knowledge are in demand by a whole range of employers as identified in the BIS report.[69]

STEM specialist employers suggest deficiencies in some STEM graduates' technical ability and subject knowledge, and also in their lack of commercial awareness. In the 2011 BIS report weaknesses in core discipline knowledge and understanding and a lack of high calibre applicants was widely commented upon, as well as for some, specific skills (in Mathematics, for example) and their general employability.[70] The HEFCE report into Strategically and Vulnerable subjects provides an excellent summary of the evidence base for the demand for STEM graduates.

63 Oakleigh Consulting/CRAC (2011) Evaluating the 2010 HEFCE-subsidised placement and internship schemes: Legacy and lessons learnt

64 1994 Group (2009) Beyond the Curriculum Opportunities to enhance employability and future life choices http://www.1994group.ac.uk/documents/public/091106_BeyondTheCurriculum.pdf

65 HOUSE OF LORDS Select Committee on Science and Technology (2012) 2nd Report of Session 2012–13: Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects Report, July 2012,p14

66 Roberts Review: Sir Gareth Roberts (2002) SET for success: The supply of people with science, technology, engineering and mathematics skills (April 2002) HM Treasury http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/media/F/8/robertsreview_introch1.pdf

67 BIS (2009) The demand for Science, Technology, Engineering and Mathematics (STEM) Skills, January 2009

68 HEFCE (2011) Strategically Important and Vulnerable Subjects: The HEFCE advisory group's 2010-11 report, September 2011 | ref: 2011/24

69 BIS (2011) STEM graduates in non-STEM jobs, BIS Research Paper number 31 March 2011

70 Ibid

Advanced manufacturing	Defence and security	Infrastructure	Healthcare and life sciences	Services
Aerospace Agrifood Automotive Chemicals Energy	Defence Security	Construction Environment and Water Transport (airports, railways, logistics, marine, ports)	Healthcare Industrial biotechnology Pharmaceuticals and medical biotechnology	Creative industries Education, skills and training Financial services Professional and business services Retail
Technology				
Low Carbon				

Table2: Summary of UKTI priority sectors

There were also reports from employers in a CBI survey[71] that STEM qualifications are not relevant enough for businesses and this has implications for the design, content and structure of HE programmes. HEIs are under pressure to ensure that their programmes are competitive and reflect the requirements for developments in technology, manufacturing and services and that graduates are aware of the need for flexible skills and qualifications to respond to changing economic circumstances and also be able to inform innovations, be enterprising and entrepreneurial for new industries and services. These requirements have an impact on curriculum content for knowledge development but also on the provision of opportunities for work-related learning and experiences.

A NE STEM employability skills review highlighted a number of key themes but stressed that HEI staff need both capacity and capability to deliver these in the curriculum. It also acknowledged the importance of professional bodies and sector skills councils in providing careers information and guidance for graduates, but notes that that there needs to be improved accessibility to these resources for both staff and students[72].

More recently Tolland and Hooper acknowledge the importance of "T shaped" skills sets, where the depth of STEM disciplinary skills is enhanced by the ability to apply knowledge across different work-based situations. They also take account of the paradigm shift in the conceptualisation of staff capability which will involve the acquisition of employer responsive skills as well as the ability to interpret labour market intelligence[73].

71 CBI (2011) Building for growth business priorities for education and skills, Education and Skills survey 2011, http://www.cbi.org.uk/media/1051530/cbi__edi_education___skills_survey_2011.pdf

72 Toland, A (2011) HE STEM Employability Skills Review, University of Birmingham on behalf of the National HE STEM programme, available at http://www.hestem.ac.uk/sites/default/files/employability_skills_review.pdf

73 Tolland A, Hooper M (2012) *Educating tomorrow's scientists and preparing graduates for work* ,The International Journal of Science in Society, vol 3 issue 3, pp 129-144

STEM Sectors Requiring Graduate Skills

Although a policy agenda of the previous Government, the report '*Building Britain's Future: New Industry, New Jobs*' captured the developing areas for the changing economy[74]. These included strategies for low carbon industries, ultra-low carbon vehicles, developing digital technologies, life sciences and pharmaceuticals. Particular emphasis was placed on advanced manufacturing industries in aerospace, use of composite materials, industrial biotechnology sectors to support a shift from oil to renewables, plastic electronics technology, and engineering and construction developments. In service sectors developments in the financial and professional services and the demands from demographic changes in health and care are all influencing how business and the UK economy will develop. This policy agenda has been recently reinforced by the coalition government and as the Wilson review identified the UKTI's '*Britain Open for Business—Growth through International Trade and Investment*' identifies a number of priority sectors to rebalance the economy[75]. These fall into five groupings, underpinned by two crosscutting themes (see Table). These developments place increasing demands on the HE STEM communities in the provision of relevant programmes of study and their emphasis on graduate skills.

The cross-cutting themes identified for priority sectors highlight the importance of inter-disciplinary and trans-disciplinary knowledge and skills of STEM graduates. This is a developing agenda in the new technology industries where there is an interest in recruiting graduates who can enter knowledge intensive organisations and quickly grasp the essentials for business competitiveness, utilise skills such as project management and systems integration and be able to apply and create new knowledge that is responsive to changes in technologies and scientific research

74 BERR (2009) Building Britain's Future: New Industry, New Jobs, http://www.berr.gov.uk/files/file51023.pdf

75 UKTI (2011) Britain Open for Business—Growth through International Trade and Investment, Crown

and services.[76] Large corporations and SMEs are looking to recruit so called 'T-shaped' people who have capabilities to solve problems, demonstrate expertise and also have skills and attributes to communicate effectively across trans-discipline teams and networks. "*Transdisciplinarity also implies people who can learn and adapt more quickly, who are better lifelong learners"*.

Several recent Government reports, including the BIS report into the Skills for a Green Economy,[77] identify this trans-disciplinary demand, for example for engineering graduates with some understanding of natural sciences, mechanical engineering with electronic knowledge, and application of chemistry for the low carbon technologies.[78] Wilson too noted the demand for these skills in his think-piece '*Reflection on knowledge and skills*':

'some businesses already do so in their recruitment, emphasising a mix of specialisms or generic graduate skills such as mental agility, adaptability and confidence. But in the interdisciplinary workplace, graduates' performance may be enhanced if they can identify both the generic and the subject-specific in their skill-set'.[79]

Wilson posed a question of whether awareness of the complementarity of disciplines is required on HE programmes and that a clear articulation on graduate skills could enhance university and industry collaborations to ensure graduates have the key skills employers require.

76 IfM/IBM (2008) Succeeding through service innovation: A service perspective for education, research, business and government, University of Cambridge Institute for Manufacturing (IfM) and International Business Machines Corporation (IBM), April 2008.

77 BIS (2011) Skills for a Green Economy, A report on the evidence http://www.bis.gov.uk/policies/further-education-skills/green-economy

78 BIS (2010) Meeting the Low Carbon Skills Challenge, Consultation http://www.bis.gov.uk/assets/biscore/corporate/docs/l/10-849-low-carbon-skills-consultation.pdf

79 BIS (2012) A Review of Business–University Collaboration, Professor Sir Tim Wilson http://www.wilsonreview.co.uk/blog/2011/10/18/70/


QUANTUM PHYSICS

Section Three: Student engagement and pedagogic practice

All the Legacy and RAPP Projects have at their heart a remit to engage learners with the STEM curriculum and to improve their learning experience. The diverse nature of the projects has meant that there have been different engagements with diverse "reaches".

HEFCE's definition of engagement as 'the process whereby institutions and sector bodies make deliberate attempts to involve and empower students in the process of shaping the learning experience'[80] suggests that the responsibility for student engagement lies with institutions and sector bodies. However the issue of student autonomy and the shared contribution to the student experience of higher education by students is a growing area that influences the range of student engagement in higher education.

A recently drafted working definition of student engagement by Trowler for the Higher Education Academy suggests

Student engagement is the investment of time, effort and other relevant resources by both students and their institutions intended to optimise the student experience and enhance the learning outcomes and development of students and the performance and reputation of the institution.[81]

The form of student engagement in HE can vary and there is a spectrum of activity that could be classed as student engagement covering individual student learning, involvement in structure and processes in higher education and individual learner identity. Engagement can have positive effects on student: improved connections with the HEI and peers and staff; more active learning within the HEI community; improved approaches to learning and gaining more from studies; personal motivation and aspirations met.

When students are made to feel fully engaged with their learning and form strong relationships with other students and staff they find learning stimulating and interesting. These students often identify strongly with the institution and enjoy the experience of being a student. Some institutions emphasise collaboration with others and with the processes and procedures of the institution and involve student in traditionally accepted structures such as through course representation, department and institutional committees or with the student union or other membership groups.

With respect to graduate skills development this is characterised in the approach the institution takes in articulating its role in developing student skills e.g.

- through university charters and mission statements
- in marketing and through course/ programme information
- through the new Key Information SET and UCAS
- in the recording of student achievement (e.g. through the new Higher Education Achievement Award)
- through the formal identification of when and how skills can be developed (learning outcomes and assessment)
- through course representation.

Trowler cited the work of Krause (2005) and lists ten "working principles" to enhance student engagement:

1. Create and maintain a stimulating intellectual environment
2. Value academic work and high standards
3. Monitor and respond to demographic subgroup differences and their impact on engagement
4. Ensure expectations are explicit and responsive
5. Foster social connections
6. Acknowledge the challenges
7. Provide targeted self-management strategies
8. Use assessment to shape the student experience and encourage engagement
9. Manage online learning experiences with care
10. Recognise the complex nature of engagement in your policy and practice[82]

The challenge for all HEIs is to embed a culture within the institution to endeavour to meet these principles. Whereas the whole spectrum of methods for engagement can be beneficial for the individual student, to improve their learning experience, a key aspect is the nature of their teaching and learning higher Education experience.

80 HEFCE(2008) Report to HEFCE on student engagement ,Centre for Higher Education Research and Information, The Open University http://www.hefce.ac.uk/pubs/rereports/year/2009/studentengagement/#d.en.64090

81 HEA (2010) Student engagement literature review, Vicki Trowler, Department of Educational Research, Lancaster University, November 2010

82 Ibid, P44

Pedagogic approaches

Effective pedagogy promotes the active engagement of the student as learner. The main aim of higher learning should be learners' independence and autonomy. This involves engaging students actively in their own learning, and ensuring that they acquire a repertoire of learning strategies and practices, develop positive learning dispositions, and build the confidence to become agents in their own learning.[83]

Teaching and learning that grounds the student with the discipline and enables them to gain the full benefits from their HE experience, to enjoy the subject and want to enter future work to apply and utilise their skills and knowledge comes from the pedagogic approaches the institution, faculty, department and/or individual teacher takes.

The TLRP concept for effective teaching centres on the ways of thinking and conceptual understanding on the subject area and connects the teaching environment with the subject and the requirements for teaching the subject. Effective student centred approaches (adapted from the TLRP review) could take account of the following areas for pedagogic development in relation to lifelong learning and teaching for employability:

Knowing the students

- The needs of the students are taken into account. This is important where adult learners, possibly in part-time study have different requirements for learning support and access to the institution
- The diversity of student background, knowledge and aspirations is recognised. This is crucially important where work-based learners are engaging with higher education as they may come with a wider life experience and tacit understandings of the area of study that younger students may not have
- Student perceptions and experiences of teaching and learning are taken into account
- Student experience and their approaches to learning and ways of studying may vary dependent on prior educational experiences
- Peer group attitudes and the mutual support of others is important especially where there are a diversity of students coming from a range of personal, social and economic backgrounds and each have difference in their social, education, and cultural capital

Effective and skilled teachers

- Effective teaching requires staff enthusiasm and support for the subject, for teaching and engagement with the learners
- The knowledge and beliefs of teacher in their approach to the discipline influences the mode and the application of different taxonomies of learning. This can be most relevant in particular for adult learning but in taking an inclusive approach to teaching diverse groups of students relates to how the student learns to learn, how they develop their knowledge and understanding of the subject, it's application in varied context, how to analyse and develop critical thinking skills in this analysis and synthesis and evaluation of accumulated knowledge

Resources and the teaching environment

- The resources and material used in relation to the subject is important, how they are selected, organised, presented and assessed and also how students access these resources especially off-campus
- How the teaching –learning environment is designed and implemented and the congruence and coherence between them. This may be particular relevant in the context of the growing interest in active learning and small group activities that are so relevant to pedagogies for employability. Collaborative learning, project based learning and problem based learning working individually and in teams are growing areas of influence in developing graduate skills and competences as well as creative and enterprising approaches to the application of knowledge

The subject and learning requirements

- What students are expected to learn and understand and the inner logic of the subject and its pedagogy, especially about changing science and technologies but also in the delivery of the knowledge through new technologies and in addressing prior learning deficits that underpin new knowledge e.g. in mathematics
- How the course is designed and the connections between learning goals, teaching and learning activities and assessment and feedback but also ensuring its validity and contemporary content
- Influences of the institution department, faculty other academic communities and validating bodies
- How students are encouraged to reflect on their learning for assessment and for personal development are crucial elements in approaches to learning for future employment, so assessment methods and feedback and feed-forward approaches are important with the opportunity for development of reflective writing

83 TLRP (2010) Effective learning and teaching in UK higher education. A commentary by the Teaching and Learning Research Programme. London: TLRP p16 . http://www.tlrp.org/pub/commentaries.html

- The growing interest not just in development of research skills but the application of research outcomes for supporting community and social requirements can be developed through approaches to teaching in the classroom and the use of lecturers own research and scholarly interests.

The pedagogic approaches are not unique to STEM but nevertheless have a particular resonance with the specific requirements for teaching and learning science, technology, engineering and maths subjects where the demand is high for teaching in specialist technical laboratories and with specialist equipment. Particular pedagogic approaches are required to support learner development in: inquiry based learning and opportunities for team working and problem solving, research experimentation, empirical observation and the ability to apply a systematic and critical assessment of complex problems and issues.[84]

Current issues: The contemporary STEM landscape

The change of National Government has affected and coincided with shifting priorities for HEIs. The National HE STEM Programme began during a time of policy flux with the establishment of the new coalition Government and the growing impact of the economic crisis in the UK and globally. These changes have impacted on the Higher Education sector as a whole and have indirectly and directly affected the outcome and direction of a number of the HE STEM projects. A dominant theme running through Government policy has been the need to support STEM and STEM-related employment sectors through policy initiatives, for example those outlined in the Government 2011 Plan for Growth which included:

- protecting spending on science and research programmes
- maintaining and reforming funding for university-business collaboration through the Higher Education Innovation Fund
- the introduction of the Research Excellence Framework (REF)
- funding to establish a network of Technology and Innovation Centres
- funding for the Manufacturing Advisory Service to improve the adoption of innovative processes

There has been an emphasis here on improving STEM teaching in schools and limited commentary on the need for improved dialogue between schools and HEIs on the education of students at A level. However there has been no specific change of direction for influencing HE STEM provision as the recent House of Commons Select Committee Report (SCR) has made clear.

For HEIs other Government policies have of course been more influential, but are intrinsically linked to the Plan for Growth. The change to the fees structure as outlined in the Higher Education White Paper 'Students at the Heart of the System' set out the Government's vision for a world-class higher education sector intending that opportunities would be more responsive to student need.[85] The White Paper reiterated the principles of the new higher education funding system, which was announced as part of the Comprehensive Spending Review 2010, and will come into effect from academic year 2012/13. This included increased and variable fees and new opportunities for unconstrained recruitment of students achieving ABB grades.

These changes in fees structures may have an impact on some of the areas that the HE STEM programme intended to address. For example, with respect to employer engagement the White Paper noted that matched funding for new HE provision as piloted by the HEFCE projects would not continue. This has not been available to these STEM projects but the learning from the pilots could have been influential going forward. However this will not now occur. More importantly may be the impact of increased fees on mature and part-time applicants to HE that may come through improved engagement with employers. There are some positive elements in that part-time students can access loans but the overall increase in fees may be a deterrent to many students who are looking to improve their skills. The restrictions on support for mature students holding an equivalent level or higher qualification could be seen as negative for those people working in STEM sectors who are looking for upskilling opportunities to meet new requirements for low carbon or green technologies.

The increase in fees is affecting student recruitment and there are concerns about the impact on widening participation from under-represented groups into HE. There are particular concerns around recruitment to STEM programmes from a widening participation and social mobility perspective with regard to unconstrained recruitment, in that AAB+ grades are most commonly gained by advantaged students at independent schools and AAB+ grades are harder to achieve in STEM subjects. The consequences for the supply of STEM graduates could be affected as some students may choose to study subjects they are more likely to achieve higher grades rather than the more difficult STEM

84 QAA Scotland(2009) *Graduates for the 21st Century: Integrating the Enhancement themes* http://www.enhancementthemes.ac.uk/docs/publications/graduates-for-the-21st-century-institutional-activities.PDF

85 BIS (2011) Students at the Heart of the System, http://bis.gov.uk/assets/biscore/higher-education/docs/h/11-944-higher-education-students-at-heart-of-system.pdf

subjects. Further, some institutions may favour subjects that recruit more students with higher grades which could impact on the provision of STEM programmes.

The Select Committee Report noted that STEM subjects are generally more expensive to teach than others and, with a system of variable fees, it is possible that STEM courses may end up being more expensive to study. The report acknowledges that employers have expressed concerns about this and the impact on graduate numbers.[86]

The HE White Paper outlined that the remaining HEFCE teaching grant should give priority to high-cost and strategically important and vulnerable subjects (SIVS) which includes STEM provision and therefore this should be beneficial for STEM disciplines going forward. However there are concerns that the level of subsidy for STEM subjects will not cover the real cost of provision. Whether the costs of teaching in new technologies and the capital investment in laboratories, materials and equipment to support research and development for low carbon, green technologies and innovations would be covered, will be scrutinised in the sector. However it is important to recognise that innovations in STEM do require trans-disciplinary and inter-disciplinary developments and that less emphasis on humanities and arts subjects may have an impact on STEM developments. This is especially at the margins where graduate employability and graduate attributes are being developed. These issues are explored in detail in the o report but : it is acknowledged here that there is currently considerable uncertainty and "churn".

STEM and the higher level skills agenda

The graduate skills agenda continues to be a policy concern at a national and local level. Graduate employment is affected by the current economic crisis but also the development of the Key Information Set, presented as a tool to help prospective students choose courses and improve accessibility of information. The KIS includes (albeit contested) data on graduate outcomes and employment prospects and this gives an increased focus to how an institution supports the development of graduate skills. Along with all other programmes, those within STEM will be scrutinised for this information and the current mixed picture about graduate outcomes may prove confusing for prospective students. The SCR recommended improved data on graduate outcomes including employability outcomes.

The SCR also recommended improvements in data around supply and demand for STEM graduates and considers this could be developed in partnership with, HESA, UCAS, UKCES, CIHE, and the Higher Education Careers Services Unit (HECSU). This then would enhance the information HEIs themselves could make available to students. More important however is the improved understanding of the demand and supply of STEM graduates. The SRC expressed strongly the need for improved Labour Market intelligence around this issue. Currently many HEIs rely of information supplied through Sector Skills Councils or through links with local employers and this may be unreliable. Many careers departments use information from the National Careers Service and this comes from similar sources. It is unclear whether it is up to date or reliable. The UKCES has supplied sector information but again this is often outdated when it becomes accessible. 87 This makes it difficult to assess where demand lies, where shortages exist and has an impact on how HE programmes are planned. The development of stronger university links with Local Enterprise Partnerships may provide opportunities for enhancing labour market information.

There is a growing demand for STEM programmes to have professional body accreditation which will provide a benchmarking and standard for STEM provision. This was a recommendation in the Wilson Review and a number of STEM-focused Sector Skills Councils are also looking at ways to kitemark courses that supply quality graduates for industry. This will give prospective students more information about how employers perceive the value of individual STEM courses.

An area with increased priority is the development of enterprise skills. This has become more important as graduate employment is effected by the economic conditions but also there is a growing emphasis on innovation which is linked with entrepreneurialism and an enterprising approach. There has therefore been an increase in student enterprise societies (70 in higher education and 10 in further education). Indeed the QAA has recently produced guidance for HEIs on enterprise and entrepreneurship education and this should inform future developments[88].

The Wilson Review recommended that businesses and universities should collaborate on applied research, employee up-skilling and collaborative degree programme development, as well as across industry sectors. In response to Wilson the Government have and HEFCE will support the Council for Industry in Higher Education (CIHE) to create a National Centre for Universities and Business, which will gather evidence,

86 HOUSE OF LORDS Select Committee on Science and Technology (2012) 2nd Report of Session 2012–13: Higher Education in Science, Technology, Engineering and Mathematics (STEM) subjects Report, July 2012 p65

87 UKCES (2010) *National Strategic Skills Audit for England, Skills for Jobs: Today and Tomorrow* ,March 2010 http://www.ukces.org.uk/ourwork/nssa

88 QAA (2012) *Enterprise and entrepreneurship education: guidance for UK higher education providers* http://www.qaa.ac.uk/Publications/InformationAndGuidance/Documents/enterprise-guidance.pdf

bring together university and business leaders, and support engagement between the various stakeholders. It will facilitate the sharing of good practice, provide networking opportunities and create high-quality information flows. This provides a potential opportunity for further developments in the STEM sectors.

Conclusion

This compendium has provided an account of the key concepts and significant issues that have underpinned the National HE STEM Legacy and RAPP projects. We have reviewed some of the key literature relating to workforce development and the demand for higher level skills. We have drawn on evidence that relates to skills required in the STEM sectors and have demonstrated that there are parts of the STEM employment related sectors that have an increasing demand for STEM graduates and that the knowledge and attributes that are demanded of these graduates fit with the changing nature of STEM –related industries and services.

The central issue for HE providers is finding ways to address employability development during a learner's experience in HE. We have therefore briefly reviewed some of the literature relevant to employability development in HE and considered the issues for the curriculum, how students can be engaged in their learning and some of the influences on pedagogic approaches.

In the accompanying Synthesis report on the Legacy and Regional Action Plan Projects we have drawn on the learning in this Compendium to demonstrate how the projects have addressed these key areas for supporting workforce development and lifelong learning and graduate skills.

Bibliography

Bullock, K, Gould, V, Hejmadi, M and Lock, G (2009) Work placement experience: should I stay or should I go? Higher Education Research and Development, volume 28, issue 5, pp 481-494 .

BIS (2010) Skills For Sustainable Growth: Strategy Document, Full Report, Urn 10/1274

BIS (2011) Evaluation of the Graduate Talent Pool Internships Scheme, Authors: Robin Mellors-Bourne and Emma Day, CRAC: the Career Development Organisation; BIS Research Paper number 28 January 2011

BIS (2011a) Supporting Graduate Employability: HEI Practice in Other Countries, The International Graduate Insight Group Ltd. (i-graduate), BIS Research paper number 40, June 2011

Bolden R, Petrov G (2008) Employer Engagement with Higher Education: A Literature Review. Compiled for the South West Higher Level Skills Project, on behalf of HERDA South West. Centre for Leadership Studies, University of Exeter, November 2008

CBI (2011) Building for growth business priorities for education and skills, Education and Skills survey 2011, http://www.cbi.org.uk/media/1051530/cbi__edi_education___skills_survey_2011.pdf

Cogent (2009) Technically Higher: Securing Skills for Science and Innovation, December 2009

Cogent, Semta, Skills for Health (2010) Life Sciences & Pharmaceuticals: A Future Skills Review with Recommendations to Sustain Growth in Emerging Technologies http://www.cogent-ssc.com/research/Publications/LSPReport.pdf

Cumming, J (2010) Contextualised performance: reframing the skills debate in research education, Studies in Higher Education, volume 35, issue 4, pp 405-419

Energy and Utility Skills (2011) Working for a Green Britain: Vol 2 Future Employment and Skills in the UK Wind & Marine Industries July 2011

Green, J (2010) The Impact of a Work Placement or Internship Year on a Student, presentation given at the 3rd Higher Education Institutional Research (HEIR) International Conference, Dublin, 2010

Gunn, V. Bell, S and Kafmann. K (2010) Thinking strategically about employability and graduate attributes: Universities and enhancing learning for beyond university. Enhancement themes. QAA.http://www.enhancementthemes.ac.uk/documents/G21C/Employability_230210.pdf

HEA (2010) Quality and Responding to Employer needs, edited by Freda Tallantyre, Jane Kettle and Judy Smith

HMGov (2010) Meeting the Low Carbon Skills Challenge, A Consultation on Equipping People with the Skills to take Advantage of Opportunities in the Low Carbon and Resource Efficient Economy, Department of Energy & Climate Change, BIS URN 10/849

HMGov (2011) Skills for a green economy: A report on the evidence, BIS, URN 11/1315

Jenkins, A (2009) Research-Teaching Linkages: enhancing graduate attributes. Overview: the aims, achievements and challenges from the Enhancement Theme, QAA, Foreword

Low Carbon Cluster Sector Skills Assessment Report (2009) Report for 11 SSCs and one statutory industry training body, December 2009

Lyons L.C. (2011) A Survey of STEM Workforce Development Needs and Opportunities in the London & South East Region, National HE STEM programme London & SE regional spoke, June 2011

Manathunga, C, Lant, P and Mellick, G (2007) Developing professional researchers: research students' graduate attributes, Studies in Continuing Education, volume 29, issue 1, pp 19-36

Muldoon, R (2009) Recognizing the enhancement of graduate attributes and employability through part-time work while at university, Active Learning in Higher Education, volume 10, number 3, pp 237-252

SEMTA (2010) Low-carbon manufacturing skills in the South West of England, Semta for the South West Regional Skills Partnership. August 2010

Taylor, P. & Bower, S (2006), Power and Transformation in Higher Education Institutions: Challenges for change, IDS bulletin Vol 37 no 6, available at http://www.powercube.net/wp-content/uploads/2010/02/Taylor-and-Bose.pdf

UK Health Departments (2010) Modernising Scientific Careers: The UK Way Forward http://www.dh.gov.uk/health/category/publications/

The National HE STEM Programme

The National Higher Education Science, Technology, Engineering and Mathematics (HE STEM) Programme was a three-year initiative funded by the Higher Education Funding Councils for England and Wales through an activity grant to the University of Birmingham in August 2009. The Programme co-ordinated its activities through six geographical regions represented by the Universities of Bath, Birmingham, Bradford Manchester Metropolitan, Southampton and Swansea, and by working in collaboration with four Professional Body Partners: The Institute of Mathematics and its Applications, The Institute of Physics, The Royal Academy of Engineering, and the Royal Society of Chemistry.

Working across the higher education sector in England and Wales, with a particular focus upon the disciplines of Chemistry, Engineering, Mathematics and Physics, the Programme supported higher education institutions in encouraging the exploration of new approaches to recruiting students and delivering programmes of study. It enabled the transfer of best practice across the higher education STEM sector, facilitated its wider adoption, and encouraged innovation. Through collaboration and shared working, the Programme focused upon sustainable activities to achieve longer-term impact within the higher education sector.

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