HEA (STEM) policy roundtable: the future of Science, Technology, Engineering and Mathematics (STEM) subjects in higher education.

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Background

The future of STEM education is a topic of national scrutiny and debate. The House of Lords Science and Technology Committee (HLSTC) recently completed an inquiry (HLSTC, 2012)¹, in response to the United Kingdom's (U.K.) government's 'Plan for Growth' (2011)² and reports from the Council for Industry and Higher Education (CIHE)³, and the Confederation of British Industry (CBI)⁴. The HLSTC's synthesis of these reports and the subsequent emerging discourse highlight a number of key concerns, and pose a number of salient questions of higher education (H.E.) STEM providers, which will be considered in this discussion paper.

STEM and economic growth

The HLSTC report highlights concerns that there are not enough STEM graduates to support the U.K. government's proposal for the future direction of the economy. The 'Plan for Growth'² identified the role of 'high-tech' industries (manufacturing and digital industries), amongst others, in driving growth. The HLSTC asserted that STEM graduates are of strategic national importance due to the relevance of the skills set that they possess to these industries. Indeed, a working definition of STEM used in the inquiry report is: "a group of disciplines that teach the skills required for a high-tech economy" (HLSTC, 2012).

It appears from the opening paragraph of the HLSTC report that their assertions have been derived from an integration of: i) the committee's interpretation of the governments' vision of the future as hinging predominantly on high-tech industry, and ii) the CIHE's vision of the future as requiring the skills set of STEM graduates⁵. The committee have, perhaps understandably, arrived at the formulation that Future = high tech; Future = STEM; and therefore STEM = high-tech. However, this formulation has resulted in a constrained view of STEM disciplines and associated graduate skills, and limits the perceived utility of these skills to a narrow area of economic growth.

The HLSTC explicitly refers to specific disciplines as exemplars of STEM (i.e. Chemistry, Physics, Engineering and Mathematics). These 'hard' sciences are directly contrasted with the 'softer' sciences, including the newer Physical Science disciplines (e.g. Forensic and Archaeological Sciences) and those within the JACS 2.0 Biological Sciences code (e.g. Psychology, Sports Sciences). HLSTC notes that these subjects "may not be considered by many to be STEM and graduates from these courses may not have sufficient STEM skills to satisfy the demands of the employment market for STEM graduates". This presumably is driven by the assumption that the predominant employment market for STEM graduates is within high-tech industry, and that STEM graduates' utility is based solely on their capacities to apply knowledge of traditional STEM subjects to high-tech industry. However, the report acknowledges that STEM graduates and postgraduates are in high demand by both STEM and non-STEM employers. Furthermore, whilst targeted specialisms and relevant work experience are important to employers, both the CIHE and CBI both acknowledge that STEM graduates are valued for their breadth of knowledge and skills, analytical thinking, problem-solving skills and numeracy, as well as for their technical or subject-specific skills. It is worth asking whether other disciplines may also deliver such attributes.

Mathematical skills

The HLSTC report indicates that higher Maths skills are of particular concern, and draws upon a range of evidence to demonstrate that the U.K. is behind competitors in post-16 Maths education⁶. Although the

¹ http://www.publications.parliament.uk/pa/ld201213/ldselect/ldsctech/37/37.pdf

² http://cdn.hm-treasury.gov.uk/2011budget_growth.pdf

³<u>http://www.cihe.co.uk/category/themes/policy/stem/</u>

⁴ <u>http://www.cbi.org.uk/media/1051530/cbi__edi_education___skills_survey_2011.pdf</u>

⁵ "Jobs of the future will increasingly require people with the capabilities that a STEM qualification provides" (CIHE, 2009)

⁶ Advisory Committee on Mathematics Education (2011) *Mathematical Needs in the Workplace and in Higher Education*. London: ACME

^{7.} http://www.heacademy.ac.uk/resources/detail/stem-project-info

report locates this problem within the secondary education sector, it suggests the H.E. sector must take some responsibility. It argues that disciplines that accept students on to STEM degrees without A-level Maths demotivate pupils to study post-16 Maths. There are implications that only A-level Maths prepares students for high-level mathematical skill acquisition, and that universities should require A-level Maths at entry; both issues are worthy of further consideration.

The discussion of the Maths skills gap is driven by the views of groups such as the CIHE, British Academy and CBI. However, whilst the Director-General of the CBI outlines the need for higher-level skills, and a need for STEM skills, these two points have become conflated and interpreted as HE STEM education delivering suboptimal skills. In reality, the report from the CBI focuses on the need to consider broader employability skills rather than identifying any deficit in maths or science skills amongst STEM graduates. Furthermore, the discussion surrounding the maths skills gap lacks sufficient acknowledgment of what STEM degrees (both 'hard' and 'soft') do for developing broader science skills and numeracy, including data collection, handling, analysis and communication. Several organisations (including examination boards, the Royal Statistical Society, Nuffield Foundation and the British Academy) are consulting on ways of addressing the gap at pre-tertiary level, and the HEA have been conducting work to identify solutions within H.E. and around student transition⁷. Further exploration of these issues, cross-sector, can only be beneficial.

STEM employability skills

Many of the broader STEM disciplines (as defined by the HEA) are interdisciplinary in nature. For example, students within Forensic and Environmental Sciences are trained to apply Biology, Chemistry and Physics to problems using an integrated approach. The Quality Assurance Agency's (QAA) STEM subject benchmarks articulate the objective of preparing graduates for work in interdisciplinary teams, skills which are acknowledged by the CBI and CIHE as important for the workplace. Whilst healthy recruitment may not make the 'softer' sciences strategically important and vulnerable subjects (SIVS), it doesn't necessarily follow that they are strategically unimportant. It might seem more appropriate to define a STEM subject according to the skill set it develops rather than its content.

STEM graduates are uniquely placed to contribute to technological innovation, but the government's 'Plan for Growth' acknowledges that high-tech industry is only the third largest sector in terms of share of UK Gross Domestic Product (after retail, and Professional and Business Services). The Professional and Business Services (PBS) sector in the UK is a net export for the nation; it has seen considerable growth in the last decade (BIS and Her Majesty's Treasury) and continues to perform well relative to manufacturing⁸. STEM degrees prepare graduates for the market research, consultancy, computer services and advertising aspects of PBS. The emphasis on high-tech industry is thus worthy of discussion.

Implications for H.E.

The H.E. sector must not lose sight of its responsibilities; universities must promote STEM to the pre-tertiary sectors, facilitate retention and success within STEM degrees, and inspire enthusiasm for STEM post-graduation. Enhancement of teaching quality within STEM in universities is therefore crucial. STEM educators need to ensure that STEM graduates have 'industry-valuable' skills, through engagement with employers, industry and professional bodies to inform curriculum development. There is also a need for continued engagement with the pre-tertiary education sector to inform the pre-university curriculum around STEM and mathematical skills to prepare students for STEM programmes at undergraduate level.

Conclusions

In conclusion, there is potential for the sector to engage with pre-tertiary educators and industry for the optimisation of STEM for economic benefit. However, this engagement would be augmented by a broadening of the understanding amongst politicians and industry of what STEM disciplines are, and the breadth and value of the skills they develop. Delegates attending the round table may wish to consider these questions:

- How should STEM be defined and which subjects should it include?
- How should we address the Maths skills gap in the UK?
- How can we promote STEM education and skill development in the UK?
- What key messages should STEM educators in HE send to government and other policy makers?