What Curriculum in UTCs? A national perspective

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HE STEM Support for University Technical Colleges (UTCs)
A national seminar on 14-19 STEM curricula and technical qualifications in UTCs

Black Country UTC - Walsall
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What matters - curriculum or qualifications?

Curriculum is everything. Definition offered here: *the sum of educational experiences provided to pupils in pursuit of the educational purposes of the school* (from Tyler 1949, Kelly 1977)

Key concepts – curriculum purpose, aims, objectives, coherence, progression (noting that none of these are value-free and hence need to be agreed by consensus on a school-by-school basis)

Sadly, because *what gets measured gets managed* we all focus so much on qualifications – and for UTCs this mostly means technical STEM. But let us return our focus on curriculum.

What has been happening?

This presentation takes place in a context –which is finally settling down enough to offer some firm statements on curriculum for others to accept or reject at their option:

- National Curriculum review
- The English Baccalaureate
- Free schools, studio schools , UTCs, more academies, new post-16 provision
- Big rise in apprenticeships
- Wolf review of 14-19 vocational education (KS4 accountability tables, post 16 programmes of study, role of ‘instructors’ in schools)
- FE STEM Project and studies on progression and wage return
- ‘Respected’ technical qualifications for use in UTCs
- Debates on the purpose of engineering qualifications in school and the ‘equivalence’ of the Diploma in Engineering

RAEng purpose statement for engineering at KS4

Engineering is one of the STEM (Science, Technology, Engineering, Mathematics) subjects **prioritised by Government and employers in the UK and in every successful nation**. It is readily associated with progression through sixth forms and apprenticeship, further and higher education and towards rewarding employment in sectors of the global economy that are vital to sustainable growth.

Engineering provides a creative and practical curriculum vehicle, enabling the application of Mathematics and Science to realistic problems that involve purposeful design, innovation, technology, computing, the realisation of functional artefacts and commercial enterprise. It directs pupils to see how they can use what they have learned to solve problems and improve lives.

Respected engineering qualifications for 14-16 year olds, such as the Principal Learning from the **14-19 Diploma in Engineering** provide the STEM learning outcomes required for progression to STEM apprenticeship, Further Education or University along with significant opportunities to design, create, and test engineered products. **These engineering qualifications at Key Stage 4 are entirely relevant to pupils on academic pathways**.

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Purpose statement for 14-16 Engineering
28th November 2011

Engineering today

The UK is in the business of high added-value, high-technology, sustainable engineering and manufacturing. In addition it needs to maintain capability in civil engineering, engineering construction, electricity production and distribution, gas, water and sanitation, transportation, process manufacture, nuclear, electronics, food manufacture, fuels, high-value materials, consumer products, IT, software and healthcare services. All depend on engineering knowledge and skills and all are signalling increasing demand and experiencing a scarcity of supply of suitably qualified young people.

What is engineering for 14-16 year olds?

Engineering is one of the STEM (Science, Technology, Engineering, Mathematics) subjects prioritised by Government and employers in the UK and in every successful nation. It is readily associated with progression through sixth forms and apprenticeship, further and higher education and towards rewarding employment in sectors of the global economy that are vital to sustainable growth.

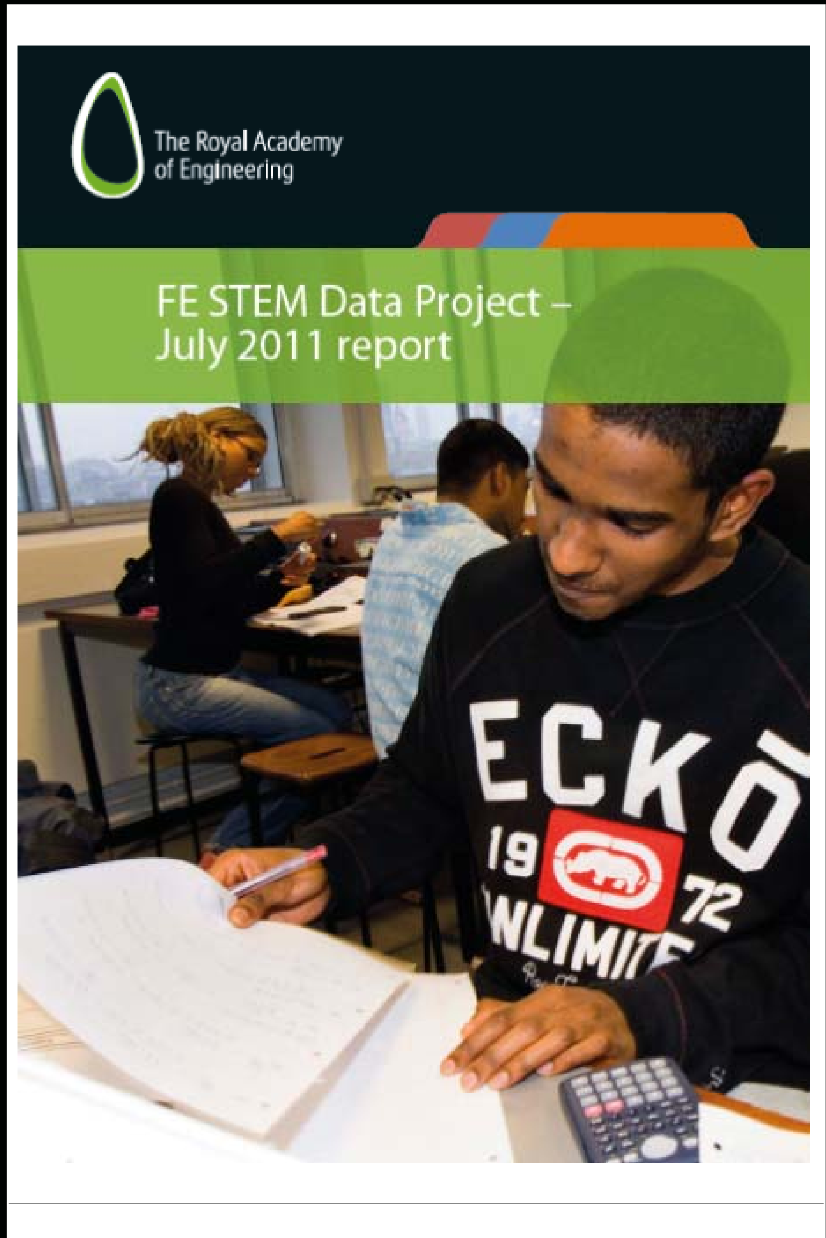
What is the relevance of Engineering to 14-16 year olds?

Engineering provides a creative and practical curriculum vehicle, enabling the application of Mathematics and Science to realistic problems that involve purposeful design, innovation, technology, computing, the realisation of functional artefacts and commercial enterprise. It directs pupils to see how they can use what they have learned to solve problems and improve lives.

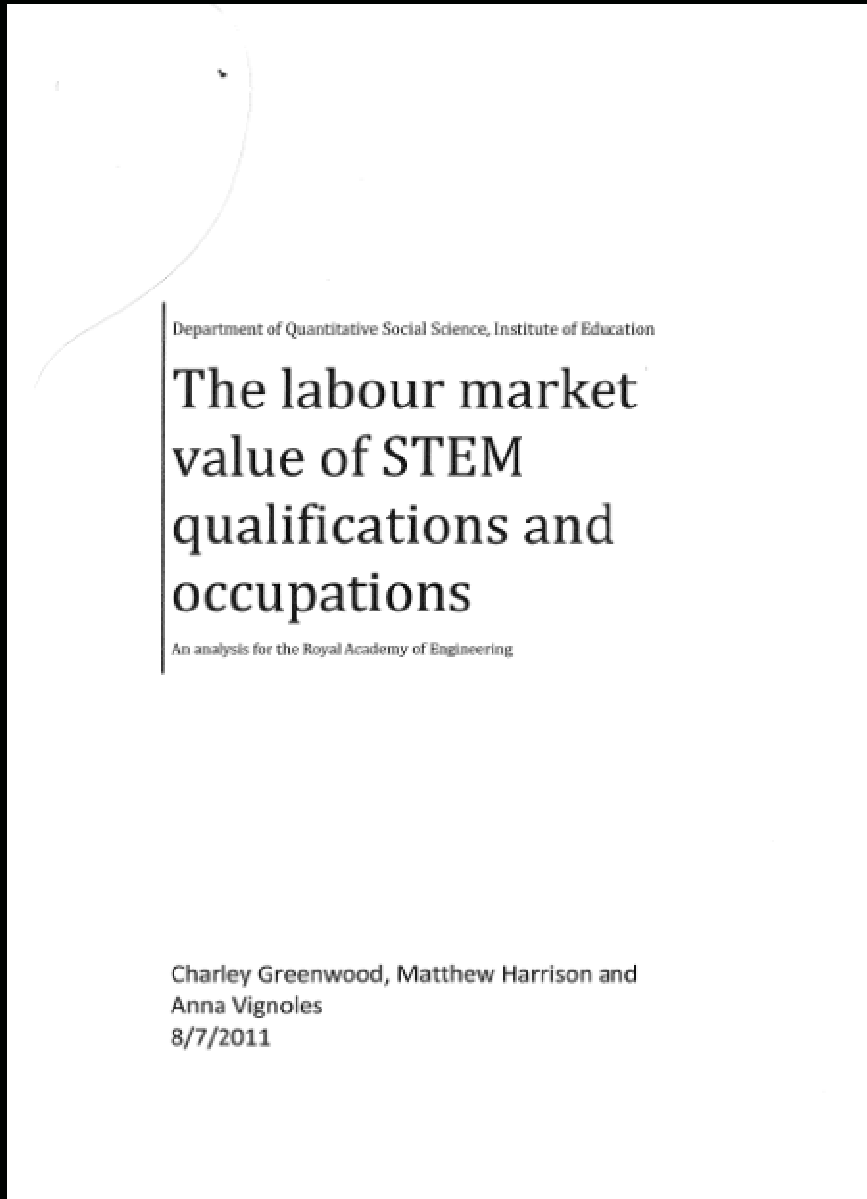
14-16 engineering curricula promote successful progression to a wide range of next steps in education and training. Building on a strong foundation in Science, Technology and Mathematics in Key Stages 1-3, engineering curricula provide an inspirational context for STEM and an opportunity for pupils to explore their identity as an engineer or technician through the solution of realistic technical problems.

Respected[1] engineering qualifications for 14-16 year olds, such as the Principal Learning in the 14-19 Diploma in Engineering provide the STEM learning outcomes required for progression to STEM apprenticeship, Further Education or University along with significant opportunities to design, create, and test engineered products. These engineering qualifications at Key Stage 4 are entirely relevant to pupils on academic pathways.

[1] A list of qualifications at Level 1 and 2 can be found in 'Respected', Technical Qualifications for use in University Technical Colleges. Baker-Dearing Education Trust / Edge Foundation / Royal Academy of Engineering, 2011.



Launched 17th November – www.thedataservice.org.uk


Department of Quantitative Social Science, Institute of Education

The labour market value of STEM qualifications and occupations

An analysis for the Royal Academy of Engineering

Charley Greenwood, Matthew Harrison and Anna Vignoles
8/7/2011

Launched 17th November – www.raeng.org.uk

Available from – The Baker-Dearing Educational Trust (September 2011)

Prioritise it enough and success will follow….

After nearly 10 years of effort from

- Government,
- Charities,
- Universities and Colleges,
- Employers,
- Learned societies
- AND schools

in promoting STEM subjects to young people there are reasons to celebrate. But there is a mixed picture across S,T,E, M

STEM data: GCSEs

There were 5,151,970 GCSE entries in the UK last year (50.9% Female). At least 40% were STEM. Source - JCQ

Triple science now up to 140,000
Annual growth in Physics 13.7% for males, 19.6% for females
Annual growth in Chemistry 13.9% for males, 18.8% for females
Annual growth in Biology 12.8% for males, 15.9% for females

Design & Technology down another 34,000 (-11.3% for males, -12.6% for females) to 250,000
ICT down another 13,000 (-24% for males,-21% for females) to 47,000
Source: JCQ

STEM data: A Levels

Last summer across the UK

Maths up 8.9% for males, 6.0% for females
Physics up 7.0% for males, 2.7% for females (but still only 6849 female candidates)
Chemistry up 10.2% for males, 8.0% for females to 48,000
Biology up 6.8% for males, 7.6% for females to 62,000
Technology subjects up 1.2% for males down 4.3% for females (dropping to only 7076 female candidates)
ICT down to 12,000 and D&T down to 18,000

Source: JCQ

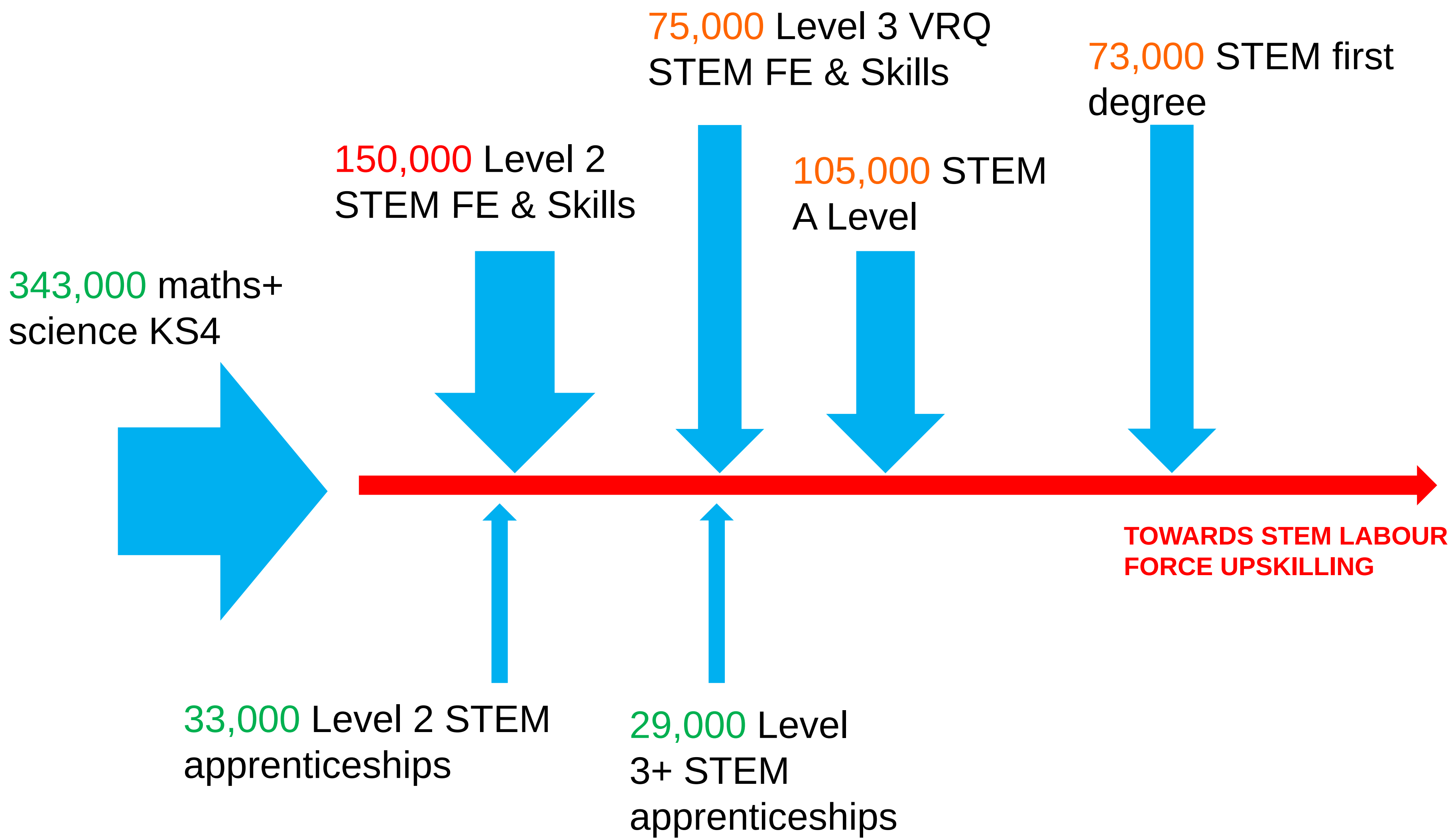
STEM data: Higher Education

In England the number of full time FTE undergraduates rose by 18% between 1999 and 2008.

The number of medical students rose by 89% (58% female)
Chemistry rose by 4% (42% female)
Physics rose by 7% (21% female)
Mathematics rose by 9% (38% female)

Computer science fell by 21% (19% female)
Engineering & Technology fell by 4% (15% female)

Source: HEFCE SIVs report, 2011



Flows of newly qualified STEM people, England, 2009/10

Green – secure numbers, amber – scaled from previous analyses, red - estimates

Email received from an Awarding Body, 3rd November 2011

We are writing to inform you that, after careful consideration [we] have decided not to take new registrations for [our] Diploma and Principal Learning courses from September 2012 next year….

The Diploma has been well received by many young people and we know from our research that areas like Principal Learning and the Project Qualifications have provided a rich and rewarding experience for learners.

However, the Diploma does not fit readily with the direction of the Government's policy, as set out in the Education Bill and other announcements regarding the curriculum, the recommendations following Professor Alison Wolf's review of vocational education, the English Baccalaureate and, most recently, the changes to performance measures. As a result the market uptake for these qualifications has diminished further from what was already a relatively small base.

Unintended consequence

The loss of provision in the 14-19 Diploma in Engineering and the deep employer engagement it fostered is surely an unintended consequence….

*It is also critical that institutions – whether highly specialised or general in their vocational orientation – maintain close links with local employers. Indeed our **third** major objective should be to recreate and strengthen genuine links between vocational education and the labour market; and especially, in the case of young people, the local labour market.*

The Wolf Report, March 2011, Page 143

STEM wage return evidence

The premium for working in STEM occupations is substantial

- 19% premium for STEM overall (average over all levels of occupation – best relative returns at occupations below Managerial)
- 10% premium for Science occupations
- 33% premium for Technology occupations (mostly computing and IT)
- 15% premium for Engineering occupations

Hybrid S/E occupations do not attract a premium.

Statistically significant evidence for substantial *additional* wage premium is found for many but not all STEM qualifications, particularly when used in SET occupations:

- First / Foundation degrees (up to 12% *additional* wage premium)
- HNC / HND (up to 11%)
- Level 3 NVQ (up to 10%)
- Level 3 City & Guilds (up to 14%)

STEM progression routes

Some well known examples of STEM progression routes exist:

- Rising rates of science A level are associated with rising rates of triple science at GCSE (DFE / BIS HLSG KPIs)
- 84% of people with 3 science A levels progress to STEM HE
  (Demand for STEM Skills DIUS, 2009
- 40% of people with BTEC Level 2 progress to BTEC level 3
  (Returns to BTEC vocational qualifications, London Economics, 2010)

STEM progression routes

Reasons to exercise caution:

- Some students are presented with fewer progression options than others

  (*Subject and course choices at ages 14 and 16*…. DFE Report RR160, 2011)

- Progression is sensitive to local context

  (*Respected…*, Edge / Baker Dearing Trust, RAEng, 2011)

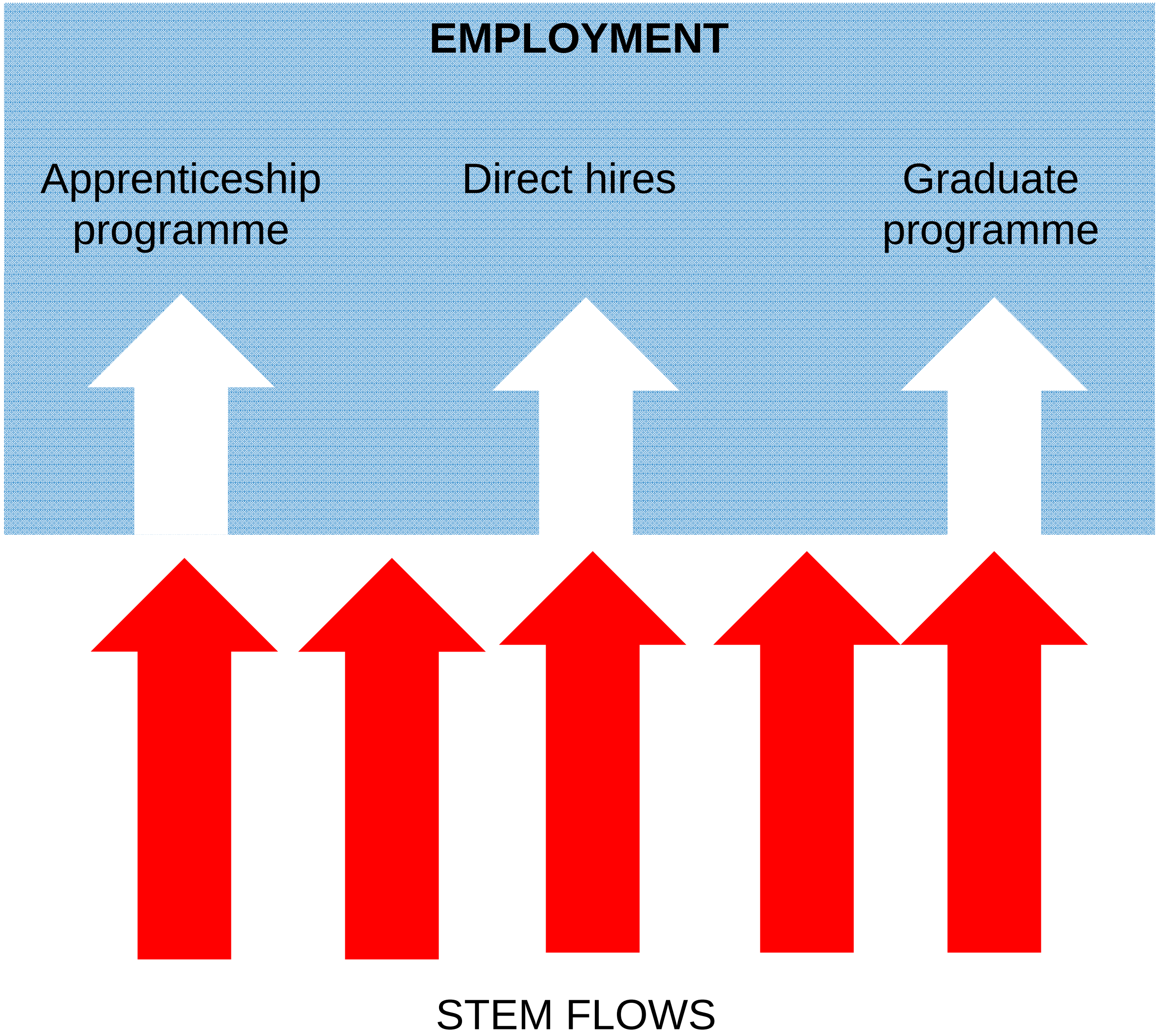
- There are more factors in play than just subject choice combinations – gender, ethnicity, socio-economics included

  (RR160, *Why choose physics and chemistry….*, IoP/RSc, 2008)

- There are multiple routes into most STEM destinations – too much emphasis on specific progression routes might imply otherwise

- Transition rates to STEM employment destinations can be surprisingly low (<50%) (HESA, *Labour market value of STEM qualifications…*

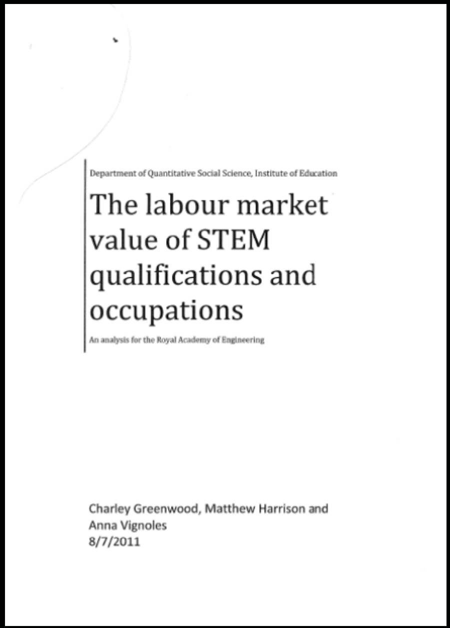
Many different STEM flow paths, fewer points of STEM access – some mismatches



STEM: people in the labour market

The most commonly held STEM qualifications by people working in STEM occupations are:

- First / Foundation degree: (3986 respondents out of 163,218)
- HNC or HND: (2014)
- City & Guilds Level 3: (1847)
- Higher degree: (1327)
- ONC / OND: (1085)
- City & Guilds Level 2: (856)
- NVQ Level 3: (671)
- BTEC Level 3: (394)
- NVQ Level 2: (380)
- Vocational degree / professional qualification: (157)
- HE Diploma: (138)
- NVQ Level 4: (68)
- BTEC First Level 2: (61)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Green – Level 4+ Blue – Level 3 Red – Level 2

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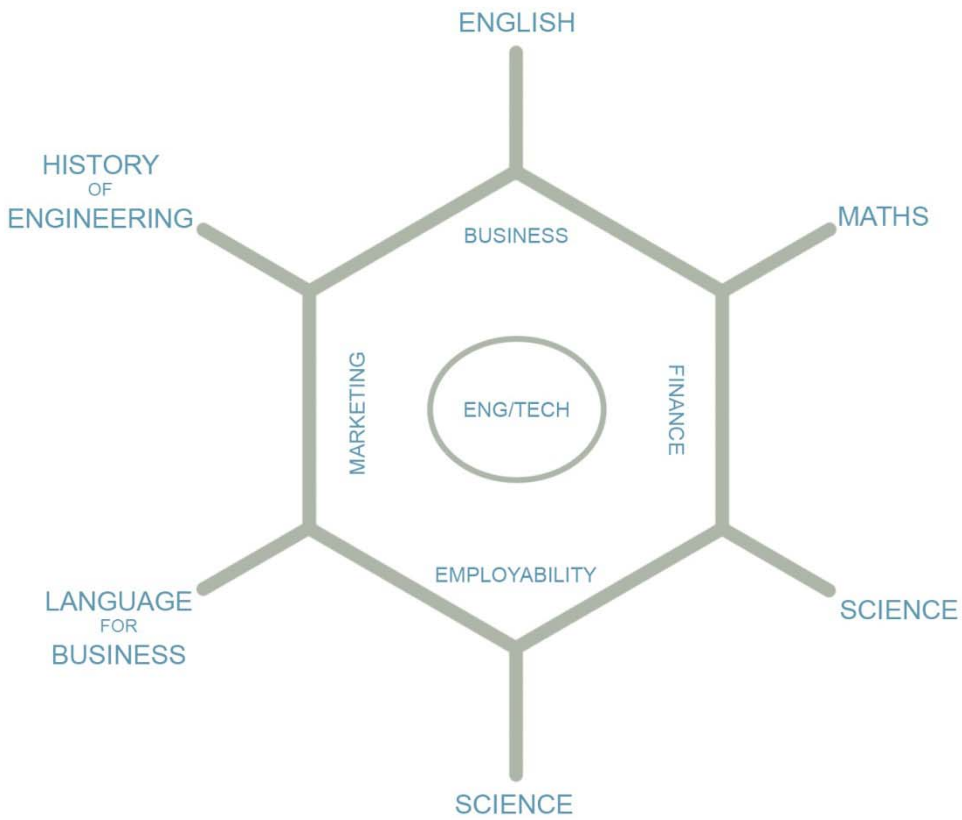
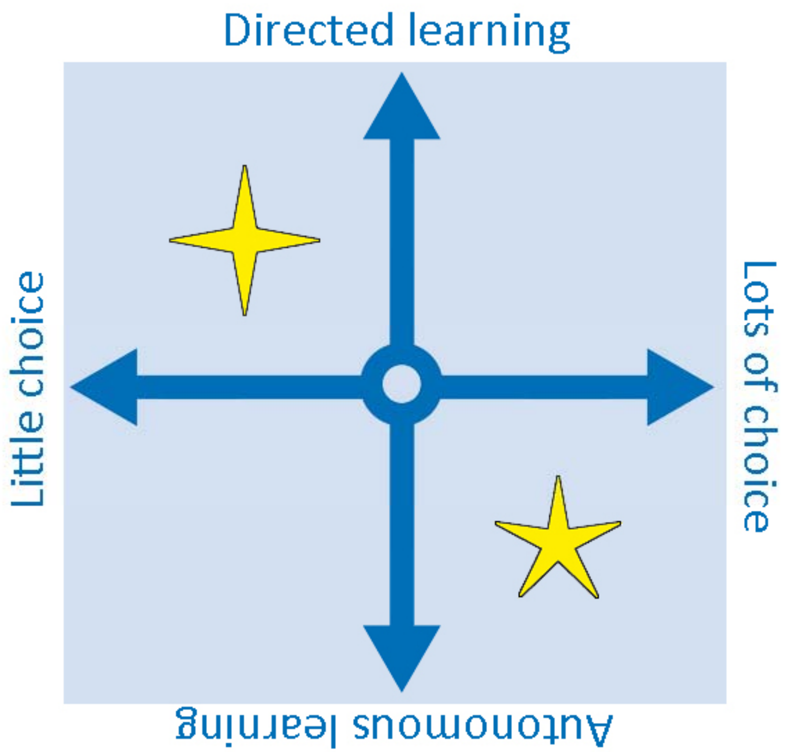
Some conceptual tools for visualising a UTC curriculum

Tomlinson 'benzene ring' shaped curriculum at Level 2



Nuffield student experience square



Source: Nuffield STEM Futures Pod 5 pupil project

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D&T pedagogy

Source: David Barlex and the Design and Technology Association

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Selecting technical qualifications for a UTC curriculum

Assuming only Wolf-compliant qualifications at Level 2 (neglecting IGCSE) means

- 10 qualifications related to Engineering / Manufacturing
- 3 qualifications related to Construction
- 6 qualifications related to Design & Technology
- 26 related to Computing (including digital literacy, IT and Computer Science)

There are very few vocational / technical science qualifications (perhaps 6). Overlap with the science in the National Curriculum make these rather distinct from other technical STEM qualifications – they won't be discussed here.

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The 'Respected' methodology for *respect and value*

Progression

Preparing for apprenticeship

Wage-return evidence

'Practical' delivery

(and achieving 5 A* - C in GCSEs including maths and English and meeting the UTC vision are givens).

Wolf-compliance deals with most of these except for the 'practical' element and meeting the UTC vision

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Practical, technical, occupational: useful distinctions when selecting technical qualifications for a UTC curriculum

An inspection of the Assessment Criteria for each unit of each qualification (available on the *Register of Regulated Qualifications*) suggests broad classifications are useful for engineering and construction qualifications:

Occupational content: engineering enterprise, how engineering organisations function, diverse engineering occupations and careers available

Technical content: applied STEM content

Practical content: hands-on technical content

Science and Computing qualifications make more sense when subject-based classification is used (3 sciences; digital literacy, IT, Computer Science)

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Engineering-related at Level 2

120+ guided learning hours (GLH)

GCSE Engineering (single award)
40% technical, 60% technical / practical
GCSE Manufacturing (single award)
70% technical, 30% practical
Edexcel BTEC L2 Extended Certificate in Engineering (180 GLH)
Depends on choice of optional units. Could be up to 100% occupational at one extreme – up to 50% practical /technical and 50% occupational at another

plus
GCSE D&T (6 product areas)
typically 40% technical, 60% technical / practical

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Engineering-related at Level 2

240+ guided learning hours (GLH)

GCSE Engineering (double award)
40% technical, 60% technical / practical
GCSE Manufacturing (double award)
70% technical, 30% practical
EAL L2 Certificate in Engineering and Technology (230 GLH)
Depends on choice of optional units. Ranging from 2/3 occupational to even mix of occupational, technical and practical
City & Guilds L2 Certificate in Engineering (300 GLH)
Depends on choice of optional units. Typically 50% occupational, 25% practical, 25% technical

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Engineering-related at Level 2

360+ guided learning hours (GLH)

EAL L2 Diploma in Engineering and Technology (330 GLH)
Depends on choice of optional units. Could be 50% occupational and 50% technical / practical at one extreme and 20% occupational, 30% technical and 50% practical at the other

Edexcel BTEC L2 Diploma in Engineering (360 GLH)
Depends on choice of optional units. Could be 80% occupational and 20% technical at one extreme and 75% practical, 15% occupational, 10% technical at the other

Level 2 Principal Learning in Engineering (420 GLH)
Even mix of occupational, technical, practical

Level 2 Principal Learning in Manufacturing & Product Design (420 GLH)
40% occupational, 40% technical / practical, 20% practical

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Construction-related at Level 2

120+ guided learning hours (GLH)

Edexcel BTEC L2 Extended Certificate in Construction (180 GLH)
Even mix of occupational, technical and practical

120+ guided learning hours (GLH)

None

360+ guided learning hours (GLH)

Edexcel BTEC L2 Diploma in Construction (360 GLH)
80% technical / practical, 20% occupational
Level 2 Principal Learning in Construction and the Built Environment (420 GLH)
Even mix of occupational, technical and practical

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Computing-related at Level 2

26 qualifications will count in the 2014 performance tables (not including Level 1 courses, IGCSEs or Level 3 courses)

11 are a mix of IT and digital literacy
9 are a mix of IT, Computer Science and (often) digital literacy
3 are devoted to Computer Science
2 are devoted to digital literacy
1 is devoted to IT

Only 14 qualifications are less than the size of 2 GCSEs - 6 are GCSE qualifications and 8 are non-GCSE. 5 of the 26 include a degree of Computer Science. Most are a mix of IT and digital literacy.

Issues around qualification size

Non GCSE qualifications larger than 120 GLH are recognised in headline school accountability tables as ‘one GCSE’.

Larger technical qualifications are more visible to pupils, parents and other stakeholders and underline the technical nature of a UTC curriculum.

Larger qualifications seem to motivate employers to engage deeper (can we identify cases of deep employer engagement at 120 GLH?) – this might change

Larger qualifications, ‘devalued’ in the minds of pupils and parents seem to have opportunity cost – how many more qualifications could they have got with the time? (this assumes ‘more is better’)

Do larger qualifications present more risk to school performance with Ofsted or in accountability tables? Opinion given to the RAEng has been mixed on this issue.

A mix of smaller technical qualifications might be attractive. Will they offer curriculum coherence? Will assessment methodologies fit together? Will they be vulnerable in a school struggling with mathematics and English?

Issues around assessment methodology

GCSE qualifications are moving (have moved) to the *linear* model with assessments only at the end of the course.

Wolf-compliant non-GCSEs have a mix of external and internal assessment. *Occupational* and some *technical* material can be assessed with

- Validity
- Reliability
- Fairness

using written examinations. *Practical* material can not.

The choice of large and small qualifications to fit into a UTC curriculum will most likely be influenced by mapping of how well (or not) the different assessment activities fit together – in terms of coherent coverage of the total curriculum and also issues of timing.

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What curriculum in UTCs?

One with deep employer engagement – the crown jewels of the UTC and its mark of distinction. (even at 120 GLH?)

One that is coherent when taken as the sum including the academic and the technical qualifications taken.

One that is endorsed - as a curriculum not as individual qualifications.

The last one is tricky as *what gets measured gets managed* and curricula don't get measured. A 'wrapper' to the qualifications achieved seems necessary. This can be endorsed by an awarding body, the school governors, employers or by a professional body.

One where the qualifications, over time, gain respect and value

This may take some time. Commonality amongst UTCs would help.