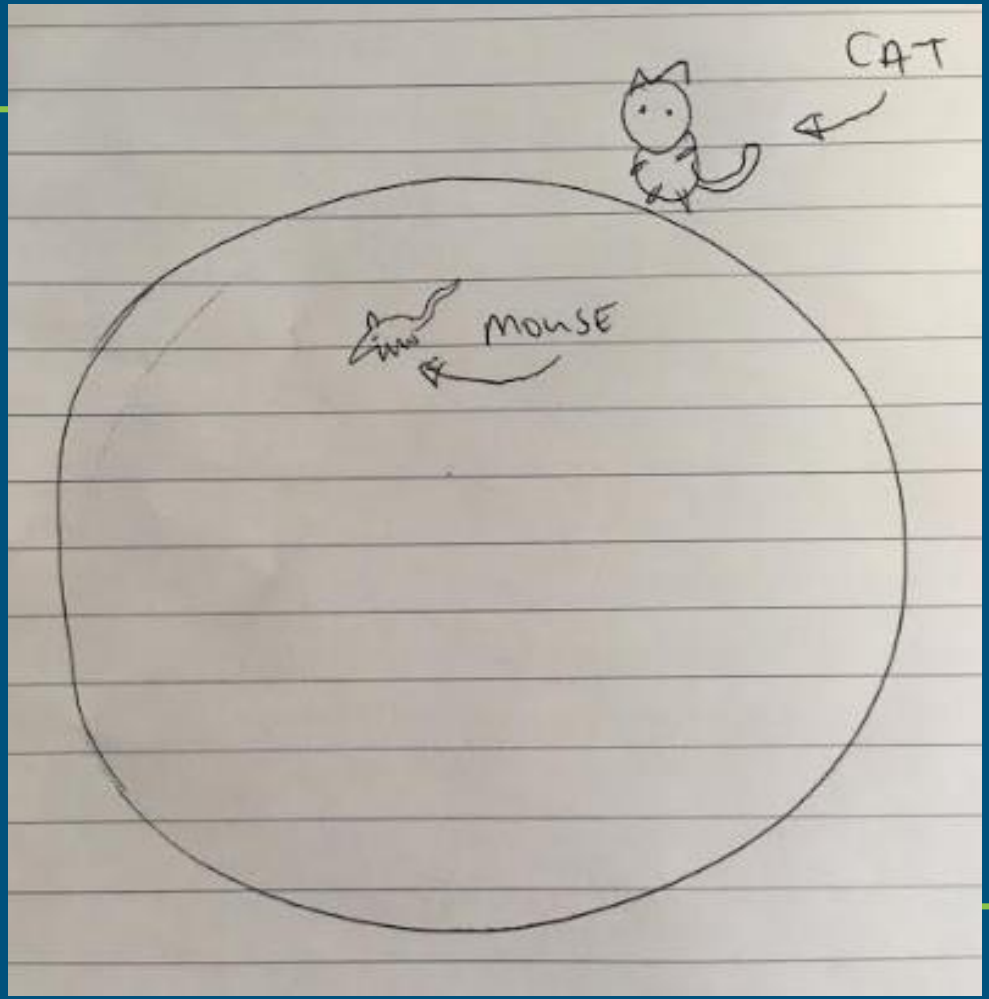
CAT
MOUSE

Ieuan Pearse

Bristol Cathedral Choir School

Level 3 Lead for the Boolean Maths Hub

Post 16 Mathematics landscape: past, present, future, implications of the Smith review and the Industrial Strategy

Industrial Strategy White Paper

Driving up the study of maths

Sir Adrian Smith's review of maths education for 16-18 year olds in England, published in July, found a strong demand for mathematical and quantitative skills in the labour market at all levels[107].

It also identified a consistent under-supply reflecting the low take up of maths among 16-18 year olds in England, and low achievement relative to other developed countries. It set out a strong case for raising participation and improving both basic and advanced maths skills: adults with basic numeracy skills earn higher wages and are more likely to be employed than those who fail to master basic quantitative skills. Higher levels of achievement in maths are associated with higher earnings for individuals and higher productivity. Strong quantitative skills are increasingly important as an underpinning for all forms of STEM study, but also for highly-skilled employment outside core STEM disciplines. As the Smith review points out, learned societies argue that students across the sciences, social sciences and humanities need significant quantitative skills, and these should be a central component of their education.

Maths should not be perceived as an exceptional talent; it is a basic skill that can be mastered with the right teaching and approach, as shown by OECD evidence from successful models such as Singapore, Switzerland and Denmark[108].

Improving the take up of maths qualifications and the quality of maths teaching across the education system is one of the most significant interventions that government can make to tackle STEM skills shortages and secure wider benefits for the economy[109].

Demand is clearly growing. For example, the UK's world-class creative industries, which cover film, TV and video games, are growing at twice the rate of the economy as a whole and are heavily reliant on STEM skills[110].

We have already taken some early actions in response to the Smith Review. This includes a level 3 Maths Support Programme, which will build on the momentum created by the Further Maths and Core Maths Support Programmes, and work with schools and colleges to improve maths education by sharing best practice and working to increase participation and attainment in maths among 16-18 year olds. The programme will work to deliver focused intervention targeted to those who need it most.

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We offer generous financial incentives for those training to teach priority subjects such as maths, and last year we trained more maths teachers than in any of the previous four years

There were almost 3,000 entries in the first year (2016)[105], and this grew to 5,361 entries in 2017[106]. To deepen the understanding of the gender disparity in STEM subject choices at ages 16 to 19, we will explore how to improve the accessibility and transparency of data published on STEM, by institution and subject.

We need to go further on maths. Building on Sir Adrian Smith's recommendation to make core maths available to all students on level 3 pathways, **we will incentivise education institutions to offer maths by providing a £600 premium to existing per pupil funding rates for each additional student who takes maths or further maths at AS/A level or core maths.** This will help education providers to support more students aged 16 and over to study maths.

We also recognise that universities are an important influence on students' choices. In response to Sir Adrian Smith's recommendations, we are working with institutions such as the Royal Society and the British Academy to encourage universities and employers to signal the value of level 3 maths qualifications for entry to undergraduate courses that have a significant quantitative element, and the value for a wide range of job roles. These investments will begin to meet

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The Current Landscape

- **GCSE reformed for first awards 2017**
- **Functional Skills reformed for 2019 →**
- **AS/A level reform in Mathematics and Further Mathematics 2017**
- **Core Maths launched 2014**
- **Sainsbury Review/Post 16 Skills Plan 2016/T levels 2017**
- **DfE/HMT Post 16 Smith Review 2016-2017**
- **Industrial Strategy 2017/8**

The Industrial Strategy

- To generate good jobs and greater earning power for all.
- We do not have enough people skilled in science, technology, engineering and maths.
- We will help people develop the skills needed for jobs of the future.
- Invest an additional £406m in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills.

Smith Report Quiz

1. From the 2010 Nuffield Report, rank these groups from the highest percentage of post-16 maths to the lowest. (88)

A - Austrailia (NSW), Netherlands, New Zealand, Singapore

B - England, Wales, Northern Ireland

C - Hong Kong, Scotland, Spain

D - Czech Republic, Estonia, Japan, Finland, Korea, Russia, Sweden, Taiwan

E - Canada (BC), France, Germany, Hungary, Ireland

Smith Report Quiz

2. The UK workforce is slightly skewed towards men (53:47) but what is the skew in jobs where mathematical science qualifications are considered essential? (95)

A - 59:41

B - 65:35

C - 70:30

D - 79:21

Smith Report Quiz

3. Not including Mathematical Sciences, what percentage of undergraduates in STEM subjects did not study mathematics beyond GCSE? (98)

A - 20%

B - 30%

C - 40%

D - 50%

Smith Report Quiz

4. What percentage of students who achieved A*-C in GCSE maths did not study mathematics any further? (136)

A - 60%

B - 55%

C - 70%

D - 75%

Smith Report Quiz

5. Put these subjects in order of popularity at A-Level in 2016/2017

A - Maths

B - Further Maths

C - English Literature

D - PE

E - DT

F - French

G - English Language

H - Religious Studies

1: Uptake of individual subjects by gender (% of A level students)

Subject	All	Male	Female
Mathematics	28.0	38.5	19.7
Psychology	20.6	10.9	28.3
Biology	19.5	17.0	21.5
History	17.8	18.3	17.4
Chemistry	16.3	18.4	14.6
English Literature	16.2	9.1	21.9
Geography	11.9	13.3	10.8
Sociology	11.4	5.8	15.9
Physics	11.2	19.9	4.3
Economics	10.0	15.3	5.8
Business Studies: Single	9.2	12.3	6.7
Religious Studies	8.4	5.8	10.4
English Language	7.8	5.4	9.7
Media/Film/TV Studies	7.0	6.7	7.3
Mathematics (Further)	5.1	8.3	2.5
Government & Politics	5.0	6.2	4.1
Art & Design (Fine Art)	4.7	2.2	6.6
General Studies	4.4	4.8	4.1
Art & Design (Photography)	4.3	2.4	5.8
Drama & Theatre Studies	4.2	2.9	5.2
English Language & Literature	4.2	2.6	5.4
Physical Education/Sports Studies	3.8	5.2	2.7
Law	3.8	3.1	4.3
D&T Product Design	3.1	5.0	1.7
French	3.1	2.2	3.8
Spanish	2.7	2.1	3.3
Film Studies	2.4	2.6	2.2
Art & Design	2.3	1.0	3.3
Information & Communications Technology	2.3	3.4	1.4
Computer Studies/Computing	2.1	4.2	0.4
Art & Design (Graphics)	1.6	1.7	1.6
Music	1.6	1.7	1.5
Classical Civilisation	1.4	1.1	1.6
German	1.2	1.1	1.4
Art & Design (Textiles)	1.2	0.1	2.1

Smith Report Quiz

6. 70% of boys who achieve A at GCSE went on to study A-Level Maths. What percentage of girls who achieve A go on to study maths? (147)

A - 75%

B - 70%

C - 60%

D - 50%

Smith Report Quiz

7. 57% of pupils who achieve an A grade at GCSE go on to study A-Level Maths. What percentage of Free School Meals students who achieve an A grade go on to study A-Level Maths? (156)

A - 39%

B - 43 %

C - 51%

D - 67%

Smith Report Quiz

8. Match the Local Authority to the percentage of students who achieve A*/A and go on to study more maths. (153)

Somerset	87%
Derby	62%
Harrow	84%
Reading	60%

Smith Report Link - https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response

(for answers to quiz - see bracketed numbers after the question for the paragraph number in the Smith Report)

The Industrial Strategy

- Of the 16 year olds who have achieved an A*-C grade in GCSE maths, fewer than a quarter continue to study maths after age 16.

- Although there has been a 20 per cent increase in entries to maths A levels since 2010, less than a third of students studying STEM related A levels go on to gain a STEM degree, and a significant proportion of STEM graduates do not go into STEM occupations.

- There is also significant regional variation in uptake of STEM subjects, including maths. In Reading in 2016, 57 per cent of students who achieved A*-C at 15 went on to study maths at level 3; in Barnsley it was 10 per cent.

- Girls are less likely to choose STEM subjects than their male counterparts.

The Industrial Strategy

Driving up the study of maths

- Sir Adrian Smith's review of maths education for 16-18 year olds in England, published in July, found a strong demand for mathematical and quantitative skills in the labour market at all levels.

- Improving the take up of maths qualifications and the quality of maths teaching across the education system is one of the most significant interventions that government can make to tackle STEM skills shortages and secure wider benefits for the economy.

- Demand is clearly growing. For example, the UK's world-class creative industries, which cover film, TV and video games, are growing at twice the rate of the economy as a whole and are heavily reliant on STEM skills.

LAs with lowest L3 mathematics participation	
Local Authority	**% study L3**
Somerset	62
East Sussex	61
Knowsley	61
Halton	61
Southampton	61
Derby	60
York	60
Barnsley	57
Salford	56

LAs with highest L3 mathematics participation	
Local Authority	**% study L3**
Redbridge	88
Reading	87
Newham	85
Brent	85
Harrow	84
Hounslow	84
Waltham Forest	83
Ealing	83
Enfield	83

Table 4a (left) and Table 4b (right). Local authorities with the lowest (left) and highest (right) proportions of those that achieved A*/A at 15 studying level 3 mathematics at 16.[148]

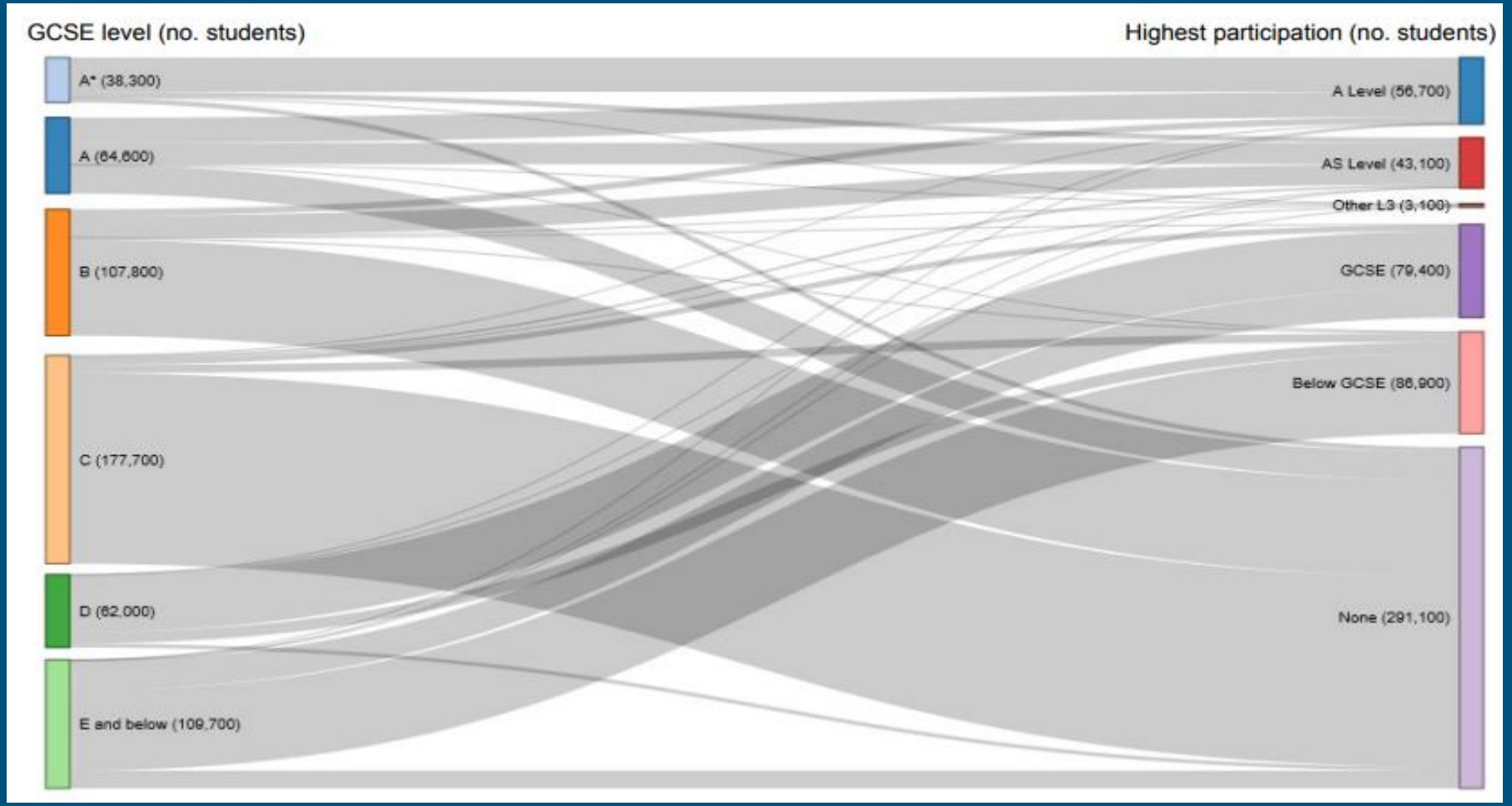
154. Though not all local authorities with the lowest level 3 participation are in the north, there is a clear north-south divide in attainment but equally no clear explanations for these differences. These figures show that local authorities with the lowest proportion of A*-C students taking level 3 mathematics qualifications tend to have lower than average achievement at mathematics GCSE. However, the significant variation in level 3 participation between some local authorities with similar mathematics GCSE attainment shows that these differences cannot be explained by prior attainment. Amongst the bottom ten areas, there are also no clear patterns in terms of local industry, prosperity, socio-economic make-up and geographical location.[149]

Table 17: Most common combinations of A level subjects, excluding General Studies, for male students (% of males with at least 3 A levels)

Combination	Percent	Cumulative percent
Biology - Chemistry - Mathematics	5.5	5.5
Chemistry - Mathematics - Physics	4.7	10.2
Mathematics - Mathematics (Further) - Physics	3.6	13.8
Chemistry - Mathematics - Mathematics (Further) - Physics	2.1	15.8
Economics - Mathematics - Physics	1.4	17.2
Computer Studies/Computing - Mathematics - Physics	1.1	18.3
Biology - Mathematics - Physics	1.1	19.4
Biology - Chemistry - Psychology	0.9	20.3
Geography - Mathematics - Physics	0.9	21.2
D&T Product Design - Mathematics - Physics	0.9	22.0

Table 18: Most common combinations of A level subjects, excluding General Studies, for female students (% of females with at least 3 A levels)

Combination	Percent	Cumulative percent
Biology - Chemistry - Mathematics	5.8	5.8
Biology - Chemistry - Psychology	2.2	8.0
English Literature - History - Psychology	1.2	9.2
Biology - Chemistry - Geography	1.0	10.2
Chemistry - Mathematics - Physics	0.9	11.1
English Literature - Psychology - Sociology	0.8	12.0
English Literature - History - Religious Studies	0.8	12.8
Biology - Mathematics - Psychology	0.8	13.6
Biology - Chemistry - History	0.7	14.3
English Literature - Government & Politics - History	0.7	15.0


GCSE level (no. students)
Highest participation (no. students)
A* (38,300)
A (64,600)
B (107,800)
C (177,700)
D (62,000)
E and below (109,700)
A Level (56,700)
AS Level (43,100)
Other L3 (3,100)
GCSE (79,400)
Below GCSE (86,900)
None (291,100)

Question:

Do we as maths teachers / school leaders have a duty or obligation to help the government increase participation in Level 3 Mathematics?

What about the £600????

What about the £600????

In February 2018 the Department for Education produced **guidance for schools and colleges** on how the Advanced Maths Premium would be calculated. Summary of the guidance:

- The funding is for each additional student, above a baseline, studying a level 3 maths qualification.
- The baseline is calculated from the mean number of students studying level 3 maths qualifications in academic years 2015-16 and 2016-17.
- Data from the Individualised Learner Records (ILRs) and October census data will be used to find the number of students.
- Core Maths and AS/A level Mathematics and Further Mathematics qualifications, along with AS/A level Statistics, and a number of other similar qualifications, are considered as level 3 mathematics qualifications. (Annex J of **this document**provides a list of eligible qualifications).
- The first year for the Premium is academic year 2018-19.
- The Premium will be paid in funding allocations in 2019-20 and for the following 2 years in the first instance.
- The Premium is paid at a rate of £600 per year per 'additional' student for one year, for AS level equivalent courses, or two years, for A level or equivalent courses.
- A student studying Maths and Further Maths will be counted twice in the same year.

What is Core Maths

Core Maths qualifications will be at least 180 guided learning hours (GLH) and results will be reported on a scale that has a minimum of four grades.

Worth the same UCAS points as an AS Level

What is Core Maths

There’s no set content but qualifications have to satisfy three objectives:

• Deepen competence in the selection and use of mathematical methods and techniques.

• Develop confidence in representing and analysing authentic situations mathematically and in applying mathematics to address related questions and issues.

• Build skills in mathematical thinking, reasoning and communication

What can we do in our schools and colleges to increase participation in all Level 3 Maths courses?

- Do you actively promote L3 maths to younger year groups?
- Do you know your gender splits?
- Do you offer Core Maths?
- Do you promote Further Maths?
- Do other subject leaders promote L3 maths?

The Industrial Strategy

- We need to go further on maths. Building on Sir Adrian Smith's recommendation to make core maths available to all students on level 3 pathways, we will incentivise education institutions to offer maths by providing a £600 premium to existing per pupil funding rates for each additional student who takes maths or further maths at AS/A level or core maths. This will help education providers to support more students aged 16 and over to study maths.

- These investments will begin to meet the demand for coveted STEM skills, as well as close the advanced maths gap that exists between our education system and the best in other developed countries.


HALF FULL
BRISTOL
BEER
FACTORY

CORE MATHS
SAMPLE QUESTIONS

1. A typical ant is about 5mm long and weighs about 3mg.

   An actor is about 2m tall and weighs about 80kg.

   A science fiction film script includes shrinking an actor to 5mm tall.
   As the actor shrinks, his weight is always directly proportional to his volume.

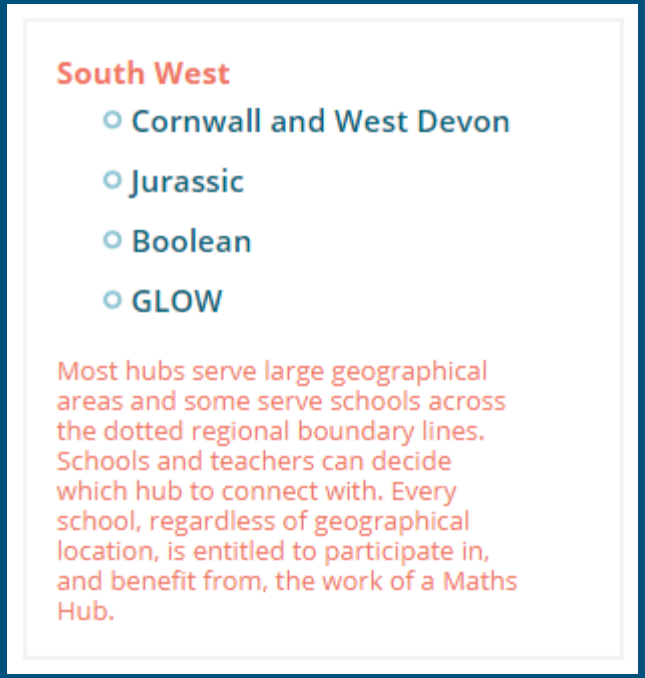
   Compare the weight of the shrunken actor to the weight of the ant.

   [5]

3 Core Maths Papers

Analyse the papers - Content, delivery, style, difficulty, accessability etc.

Collaboration at L3 Across the Region



Core Maths - Boolean and GLOW

Pedagogy in A Level Teaching - CODE, Boolean, Jurassic and GLOW

Use of Technology (Geogebra) - GLOW and Boolean

So, in our lessons we need to be imparting strong subject knowledge, ***which requires us to be a confident knowledge-deliverer****. We need to also be capable of making references to wider knowledge, to broader contexts, to 'the big picture'. All of this means thinking about what we need to do to* ***ensure that we remain up-to-date and energised by our subject, and able to take learning beyond the specification****. The data in our study strongly suggests that ensuring we are highly knowledgeable and an enthusiastic expert in our subject and that we have opportunities to renew and update (see Document 7 and Case Study 1 & 2 for examples of effective opportunities trialled in this project) is absolutely critical to our students' learning experiences and their outcomes.*

http://www.ctksfc.ac.uk/218/lsef-research-project