Using the NPD to monitor the longitudinal impact of national curriculum reform: *science as a case study*

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PLUG Conference

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Overview of talk

- **Ancient (?) history** – selects reports/developments in education policy since the 50s – the way things were
- **More recent history** – the 2006/2008 science 'reforms' – the rhetoric at least has moved on.
- **The Enactment and Impact of Science Education Reform (EISER) project** – aims and objectives of the work
- **Methods** – how we used the NPD
- **Select findings** – KS4/5 participation, attainment, value-added…
- **Summary**
  - Key points – some taken forward to the ongoing national curriculum review
  - Relation to policy

Crowther report ('15-18') 1959

Although two or three GCEs will, we believe, prove to be in the reach of more modern school pupils than would have been thought possible a few years ago, these pupils are never likely to be more than a small fraction of the total.

Many, probably more than half, of the pupils of the modern schools would have their education deflected from its proper lines by being prepared for an external examination.

http://www.educationengland.org.uk/documents/crowther/

Newsom report ('Half our future') 1963

The girl may come to the science lessons with a less eager curiosity than the boy … . Whether science to her is friend or enemy she will be better equipped by having some inkling of its nature.

The whole question of courses and materials for teaching science to the ordinary boy or girl, needs bold and thorough experiment.

http://www.educationengland.org.uk/documents/newsom/

Higginson report (review of A-levels) 1988

An ongoing tension:

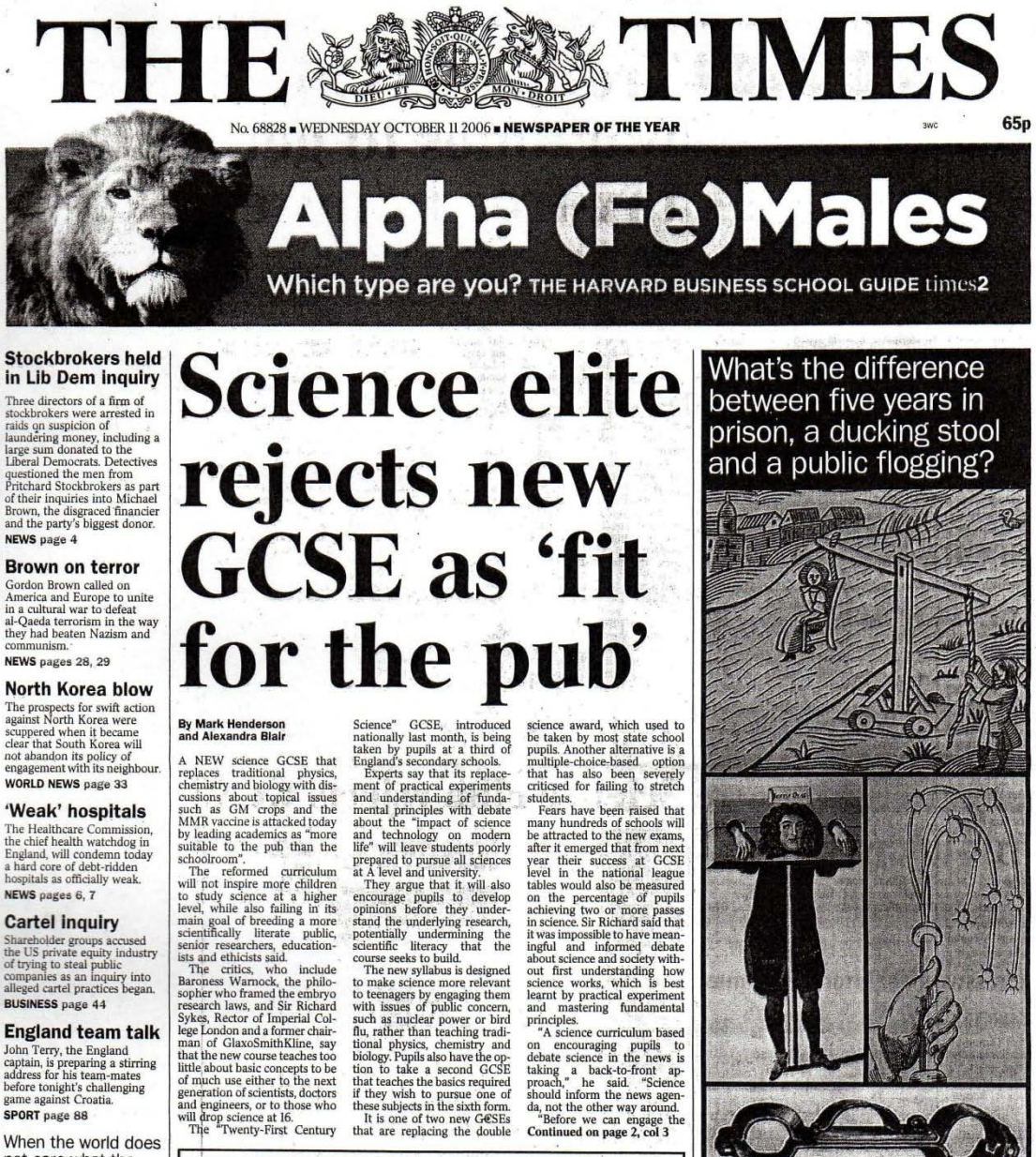
The most fundamental error in the traditional system was that each stage was designed to be suited to those who were going on to the next. School children who were not good enough to go on were regarded as expendable.

The other view …is that each stage of education should be designed for the main body of those who take it and the following stage has to start from where the previous stage ended.

…with thanks to Andrew Hunt for bringing these quotes to my attention

Recent reforms: new science curriculum for 14-16 year olds introduced in England in 2006

- Flexibility: a greater variety of ‘routes’ through KS4 science.
- A focus on teaching about the nature of science and socio-scientific issues – *How science works*
- Enhanced presence of vocational science courses (‘applied sciences’).



THE TIMES

No. 68828 ■ WEDNESDAY OCTOBER 11 2006 ■ NEWSPAPER OF THE YEAR 3WC 65p

Alpha (Fe)Males

Which type are you? THE HARVARD BUSINESS SCHOOL GUIDE times2

Stockbrokers held in Lib Dem inquiry

Three directors of a firm of stockbrokers were arrested in raids on suspicion of laundering money, including a large sum donated to the Liberal Democrats. Detectives questioned the men from Pritchard Stockbrokers as part of their inquiries into Michael Brown, the disgraced financier and the party's biggest donor.

NEWS page 4

Brown on terror

Gordon Brown called on America and Europe to unite in a cultural war to defeat al-Qaeda terrorism in the way they had beaten Nazism and communism.

NEWS pages 28, 29

North Korea blow

The prospects for swift action against North Korea were scuppered when it became clear that South Korea will not abandon its policy of engagement with its neighbour.

WORLD NEWS page 33

'Weak' hospitals

The Healthcare Commission, the chief health watchdog in England, will condemn today a hard core of debt-ridden hospitals as officially weak.

NEWS pages 6, 7

Cartel inquiry

Shareholder groups accused the US private equity industry of trying to steal public companies as an inquiry into alleged cartel practices began.

BUSINESS page 44

England team talk

John Terry, the England captain, is preparing a stirring address for his team-mates before tonight's challenging game against Croatia.

SPORT page 88

When the world does

Science elite rejects new GCSE as 'fit for the pub'

By Mark Henderson and Alexandra Blair

A NEW science GCSE that replaces traditional physics, chemistry and biology with discussions about topical issues such as GM crops and the MMR vaccine is attacked today by leading academics as "more suitable to the pub than the schoolroom".

The reformed curriculum will not inspire more children to study science at a higher level, while also failing in its main goal of breeding a more scientifically literate public, senior researchers, educationists and ethicists said.

The critics, who include Baroness Warnock, the philosopher who framed the embryo research laws, and Sir Richard Sykes, Rector of Imperial College London and a former chairman of GlaxoSmithKline, say that the new course teaches too little about basic concepts to be of much use either to the next generation of scientists, doctors and engineers, or to those who will drop science at 16.

The "Twenty-First Century Science" GCSE, introduced nationally last month, is being taken by pupils at a third of England's secondary schools.

Experts say that its replacement of practical experiments and understanding of fundamental principles with debate about the "impact of science and technology on modern life" will leave students poorly prepared to pursue all sciences at A level and university.

They argue that it will also encourage pupils to develop opinions before they understand the underlying research, potentially undermining the scientific literacy that the course seeks to build.

The new syllabus is designed to make science more relevant to teenagers by engaging them with issues of public concern, such as nuclear power or bird flu, rather than teaching traditional physics, chemistry and biology. Pupils also have the option to take a second GCSE that teaches the basics required if they wish to pursue one of these subjects in the sixth form.

It is one of two new GCSEs that are replacing the double science award, which used to be taken by most state school pupils. Another alternative is a multiple-choice-based option that has also been severely criticised for failing to stretch students.

Fears have been raised that many hundreds of schools will be attracted to the new exams, after it emerged that from next year their success at GCSE level in the national league tables would also be measured on the percentage of pupils achieving two or more passes in science. Sir Richard said that it was impossible to have meaningful and informed debate about science and society without first understanding how science works, which is best learnt by practical experiment and mastering fundamental principles.

"A science curriculum based on encouraging pupils to debate science in the news is taking a back-to-front approach," he said. "Science should inform the news agenda, not the other way around.

"Before we can engage the

Continued on page 2, col 3

What's the difference between five years in prison, a ducking stool and a public flogging?

A high profile reform indeed!

This comment relates to one particular element of the reform – twenty-first century science specification

Our project: Enactment and Impact of Science Education Reform (EISER)

Mixed methods, 2008-2011: jointly funded by the Gatsby Charitable Foundation and the Economic and Social Research Council

This study examines school responses to this major curriculum reform. A particular focus is teacher enactment of the science curriculum in the classroom. The study is also investigating the initial impact of these reforms on ***student achievement****, attitudes towards science education and* ***participation*** *in post-compulsory science courses.*

Document analysis, interviews with teachers and students, **NPD analysis**

Jim Ryder, Indira Banner, Matt Homer, Jim Donnelly…

http://www.education.leeds.ac.uk/research/projects/enactment-and-impact-of-science-education-reform-eiser

Multiple aims of reform

Immediate	Longer Term
Increase student interest in their science education Improve student attainment as measured through external examinations	Support students in engaging effectively with science-related issues as citizens Increase post-compulsory participation in science education Ensure adequate supply of scientists/engineers Increase the employability of students Improve social mobility and inclusion

Ryder and Banner (2011)

Use of NPD datasets in EISER

- What are the patterns of participation and attainment across KS4 and KS5 science courses?
- How is this changing over time?
- What are the possible influences on participation and attainment?

Five successive KS4 cohorts

- Two pre-2006 reform: 04-06, 05-07
- Three post-reform: 06-08, 07-09,08-10

(all based on Year 10 census)

Caveats

- Entitlement to 'Triple award' (from 2008 for high KS3 attainers)
- Not an experiment – so no causation can be inferred
- Limited and problematic data post-16

KS4 – participation and attainment

KS4 course breakdown

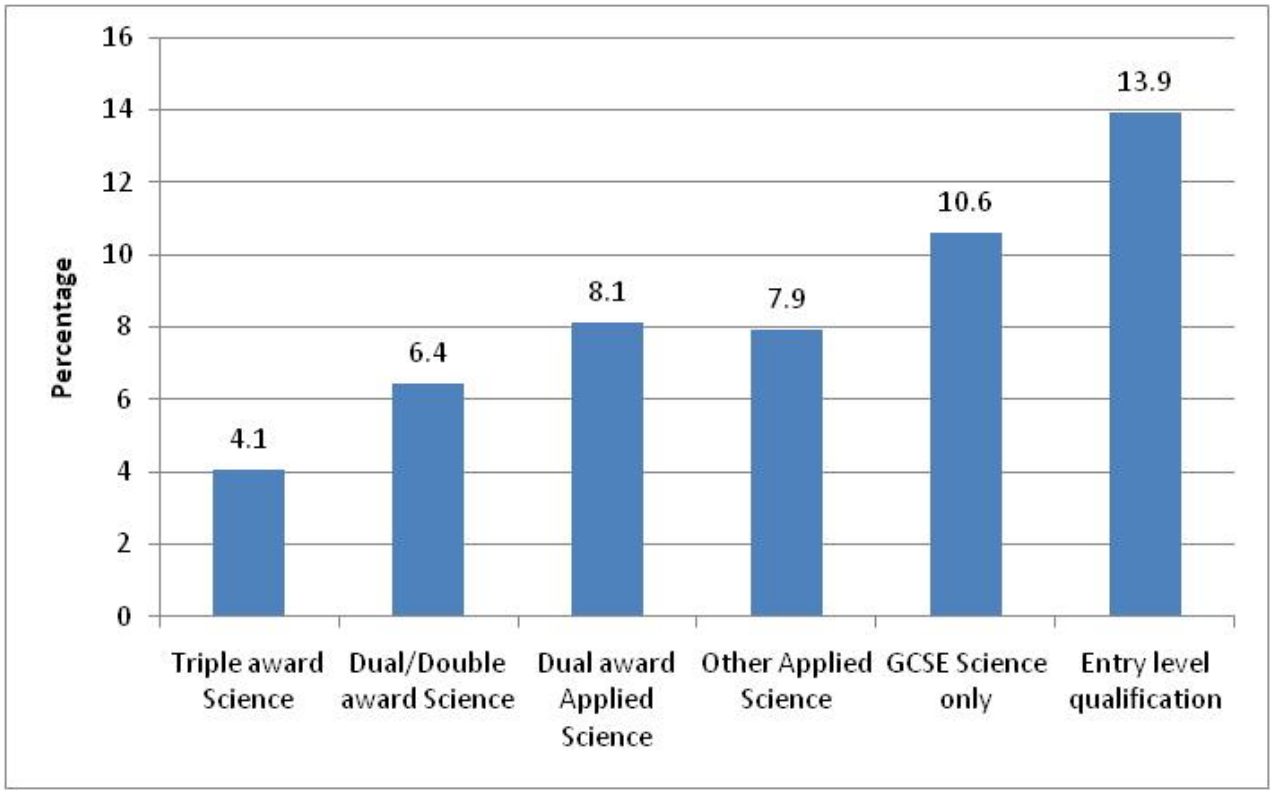
Analysis across seven main science KS4 ‘courses’ – ordered below roughly in degree of emphasis on traditional scientific content (most to least)

Course	**Description and GCSE‘size’**
1. Triple Award Science	Separate Biology, Chemistry and Physics (3 GCSEs)
2. Dual Award Science	Core and Additional Science (2)
3. Dual Award Applied Science	Core and Additional Applied Science (2)
4. Other Applied Science	Other vocational science courses (2 or 4)
5. GCSE Science Only	Core Science only (1)
6. Entry Level Science Qualification	Lower level courses (below GCSE)
7. None of the above science courses	Students without achievement in any of the above categories

- Different ‘sizes’ bring methodological issues - attainment
- Evidence of systematic variation across these in many different ways e.g.…

Pupil mobility – variation across courses

Percentage of students where schools don't match (KS3 to KS4)



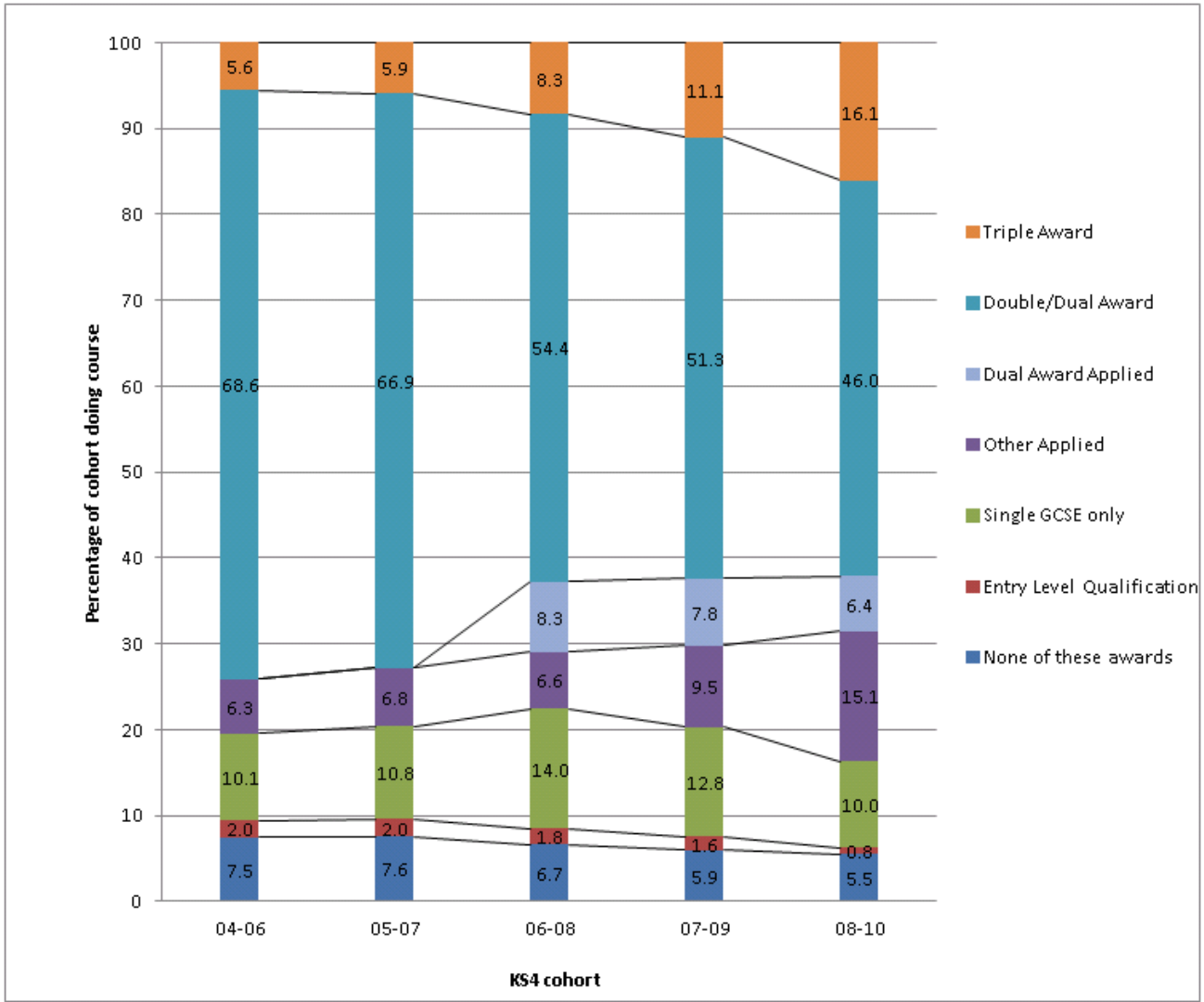
Main message:

There are higher levels of mobility for students on courses with less emphasis on traditional academic content.

(first post-reform cohort – 06-08)

Implications for value-added analyses and impacts on attainment (Leckie 2008)

KS4 participation – longitudinal

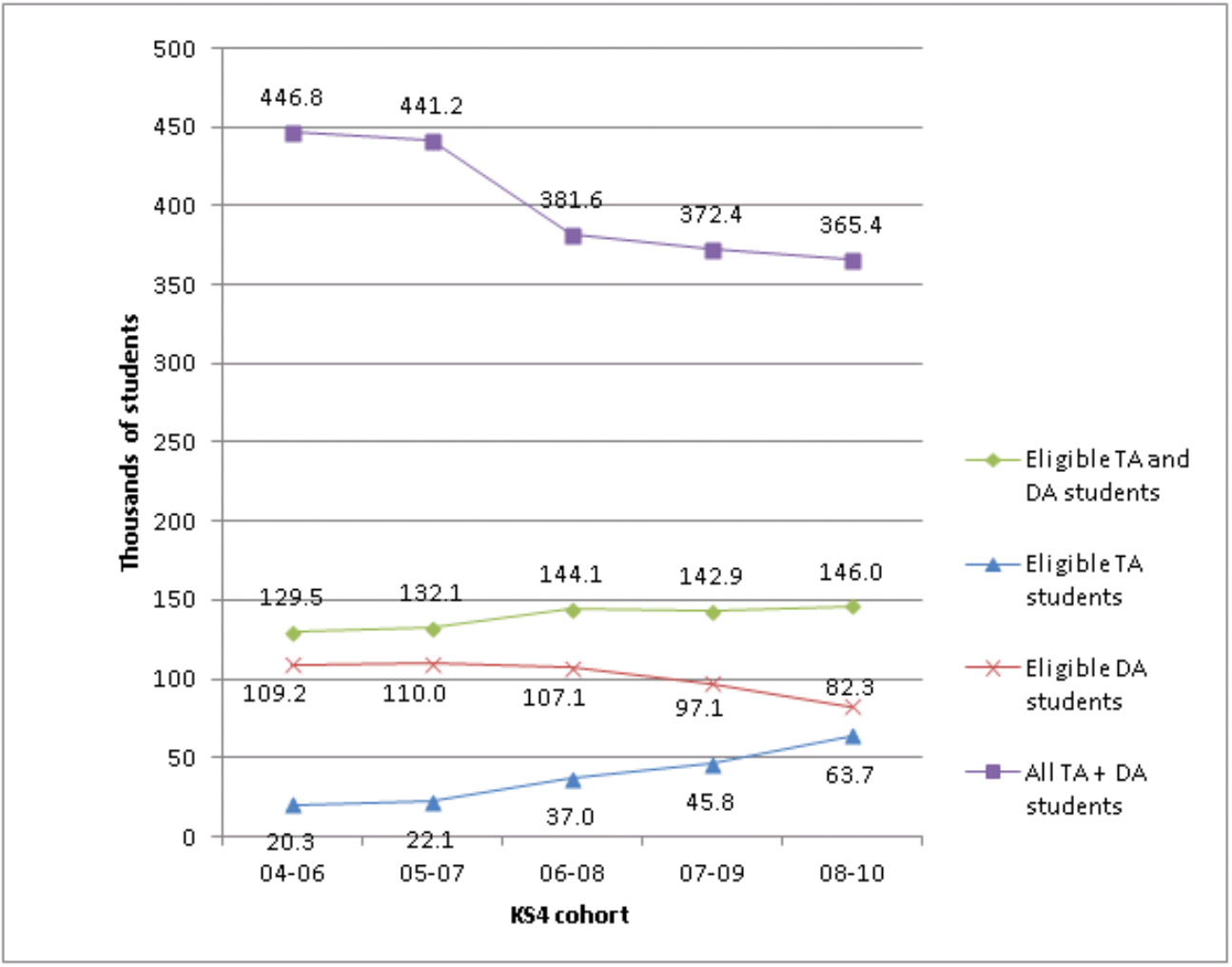


Main messages

- Diversification of KS4 participation
- Triple award growth – not slowing yet
- Dual award decline
- Applied growth, especially Other applied (BTEC, OCR).
- Role of KS3 attainment – later
- Impact on post-16 progression - later

Progression to post-16 science

The number of students 'eligible' for progression to AS-level science courses



An indicative analysis

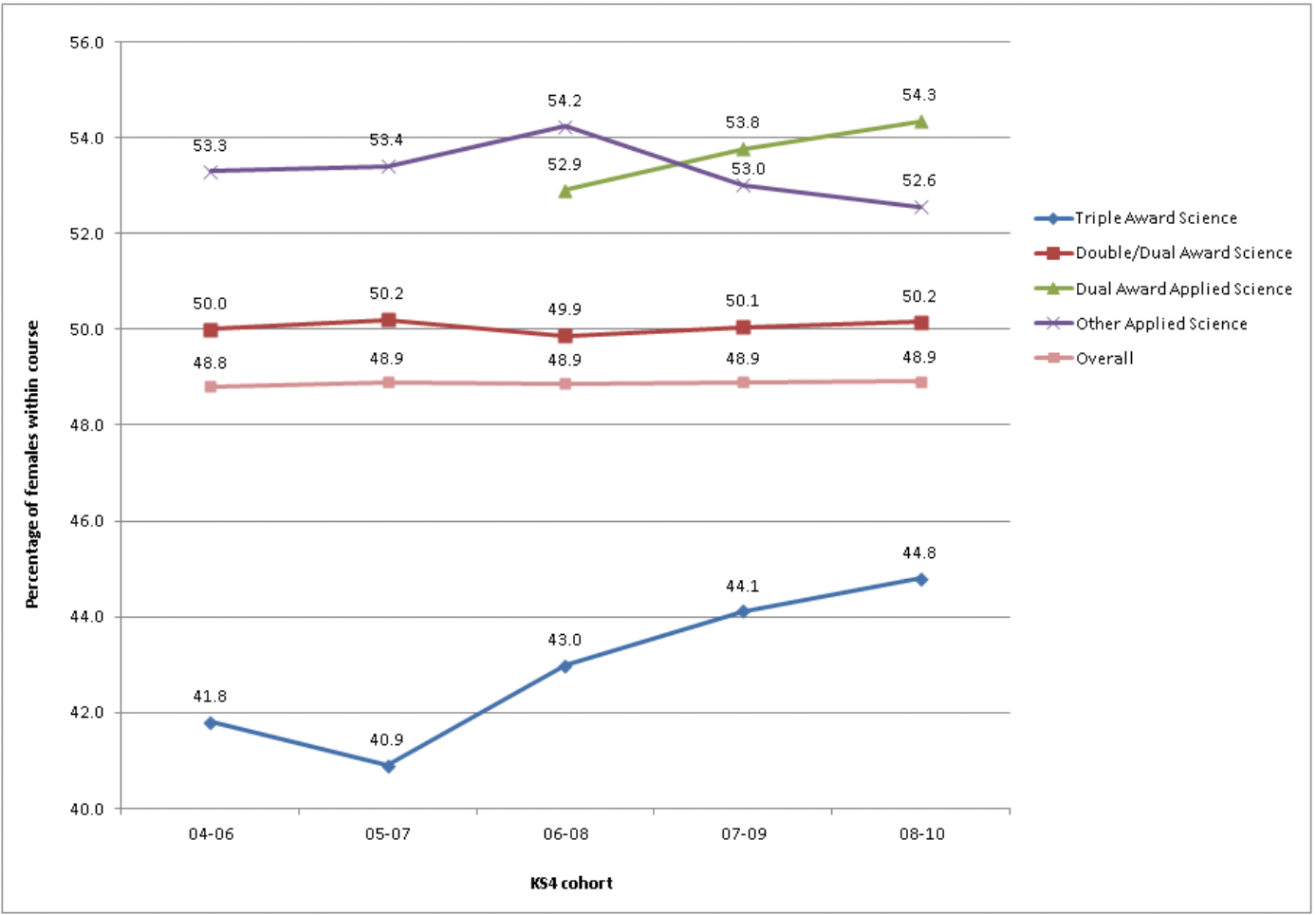
Eligible = at least a 'B' on average, so BB (Dual)or BBB (Triple) at least. Schools vary in their exact policies.

Main messages

- Decline in total number doing TA or DA (purple)
- Small decline in eligible DA numbers (red)
- Strong increase in TA eligible numbers (blue)
- Overall increase in eligible numbers (green)

GENDER: KS4 participation – longitudinal

Percentage of female students within select KS4 courses

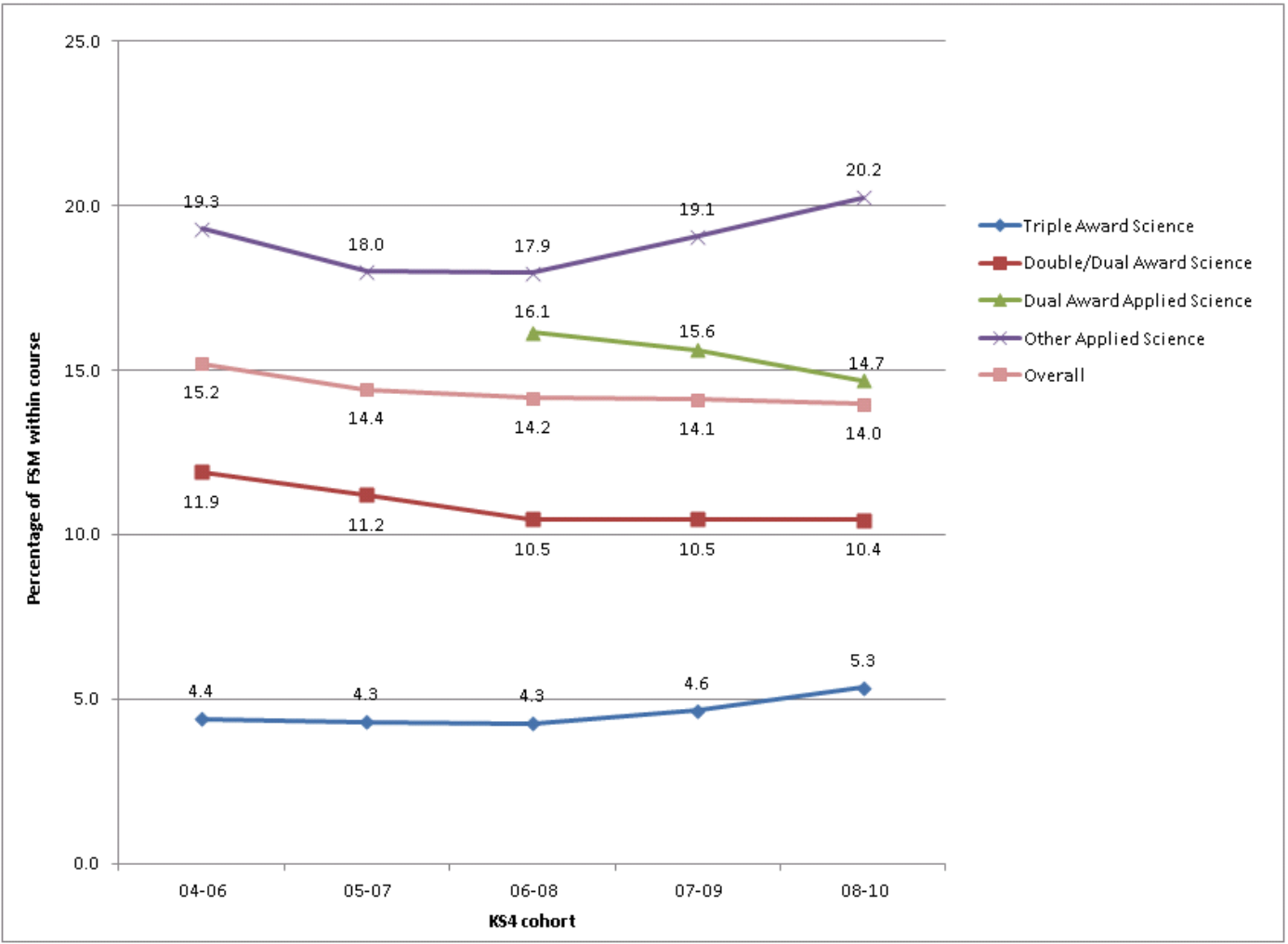


Main messages

- Triple award moving towards gender balance
- Dual award - no change
- Dual award applied – girls becoming more over-represented
- Other Applied – some evidence of a move towards gender balance
- KS3 attainment?

FSM: KS4 participation – longitudinal

Percentage of FSM-eligible students within select KS4 courses

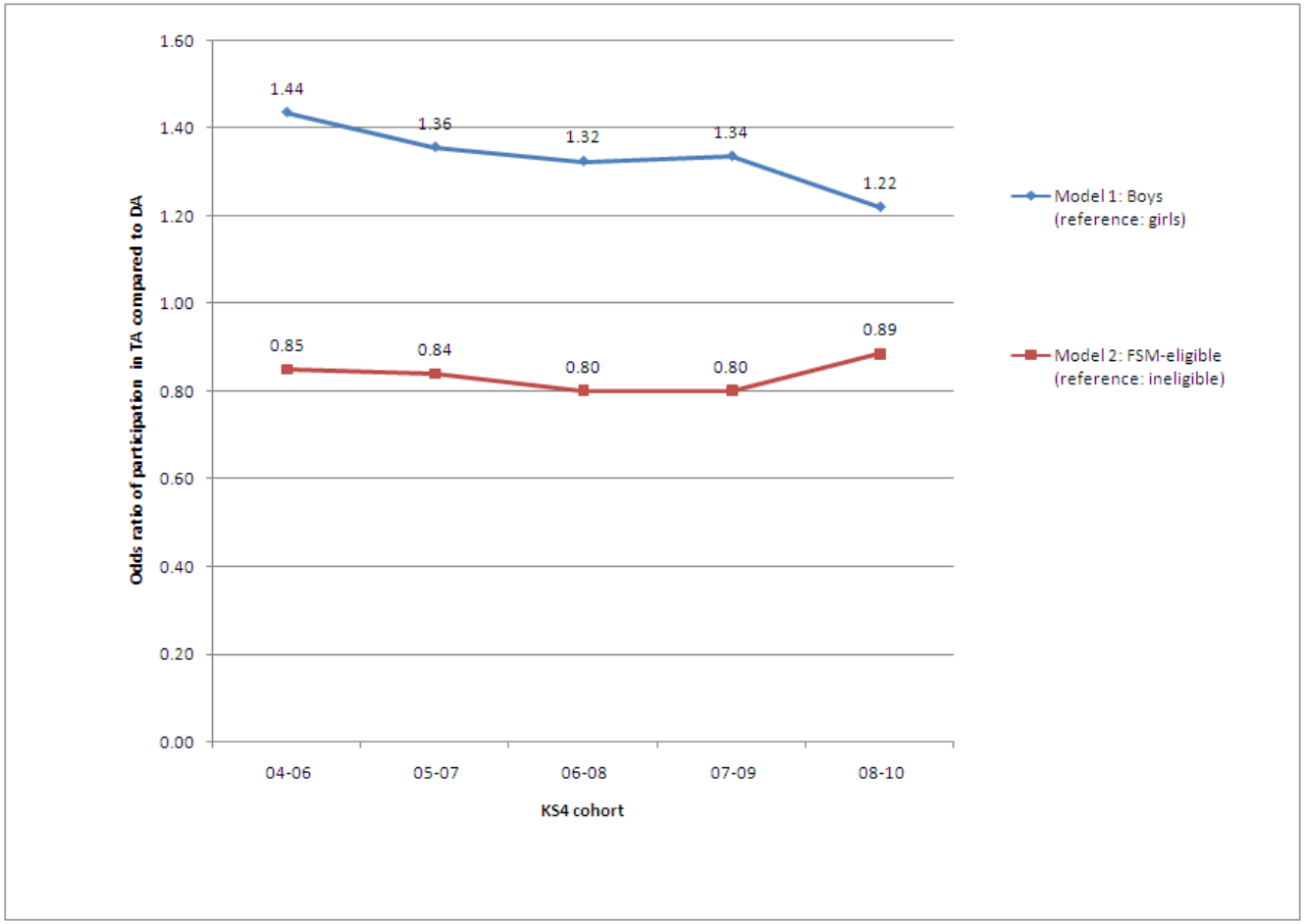


Main messages

- FSM students are becoming more equally represented in Triple award (?), but still strongly under-represented
- Dual award applied – FSM students proportionately represented
- Other Applied – FSM students over-represented
- KS3 attainment?

GENDER/FSM: KS4 participation

Controlling for prior attainment at KS3 - Triple award (TA) versus Double award (DA)



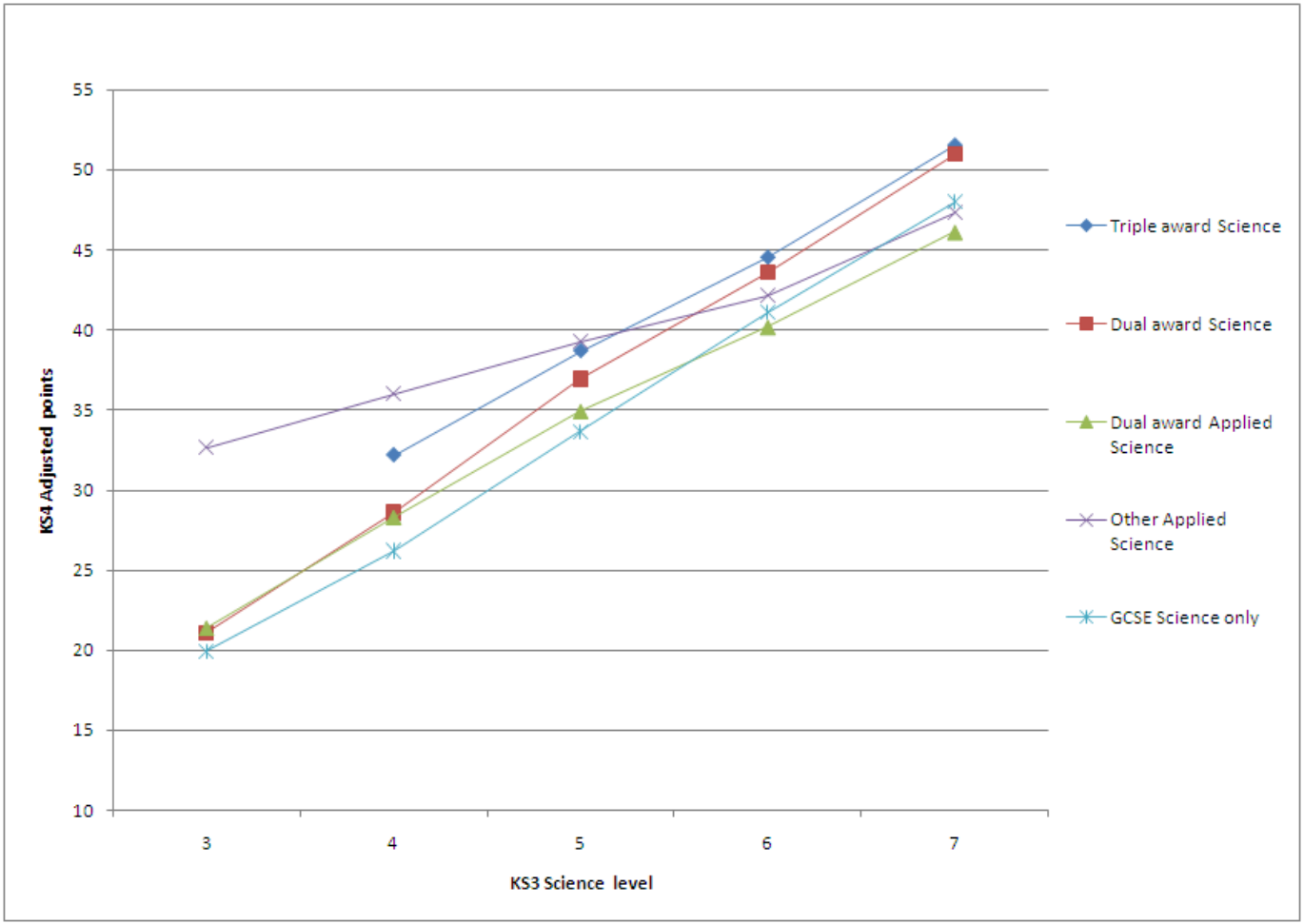
Logistic regression: plot of odds ratios - participation in TA versus DA *having accounted for KS3 science level*

Main messages

- Boys more likely to do TA than girls but a downward trend over time
- FSM-eligible students remain less likely to do TA – hint of move to 'parity' over time?

KS3 to KS4 value-added across courses

Mean KS4 performance by KS3 level



Main message:

There are widely differing amounts of 'value-added' across the set of KS4 science courses.

Vertical scale: Mean GCSE points, with 6 points = a GCSE grade

(first post-reform cohort – KS4 06-08)

Other KS3 to KS4 value-added findings

A more complex, multi-level modelling (random intercept, variance components, pupils in schools) approach finds that:

- Prior attainment in science is the most important predictor of KS4 outcomes across all courses (reassuring?).
- The relative importance of prior attainment in mathematics and English in influencing KS4 outcomes varies.
- Gender – small independent effect
- Students with lower SES tend to have lower KS4 outcomes, despite controlling for prior attainment (i.e. they make less progress).
- Ethnic minority students tend to make greater progress than do their white British counterparts (but…subtle issue because many groups have lower absolute attainment)

KS5 – participation and attainment

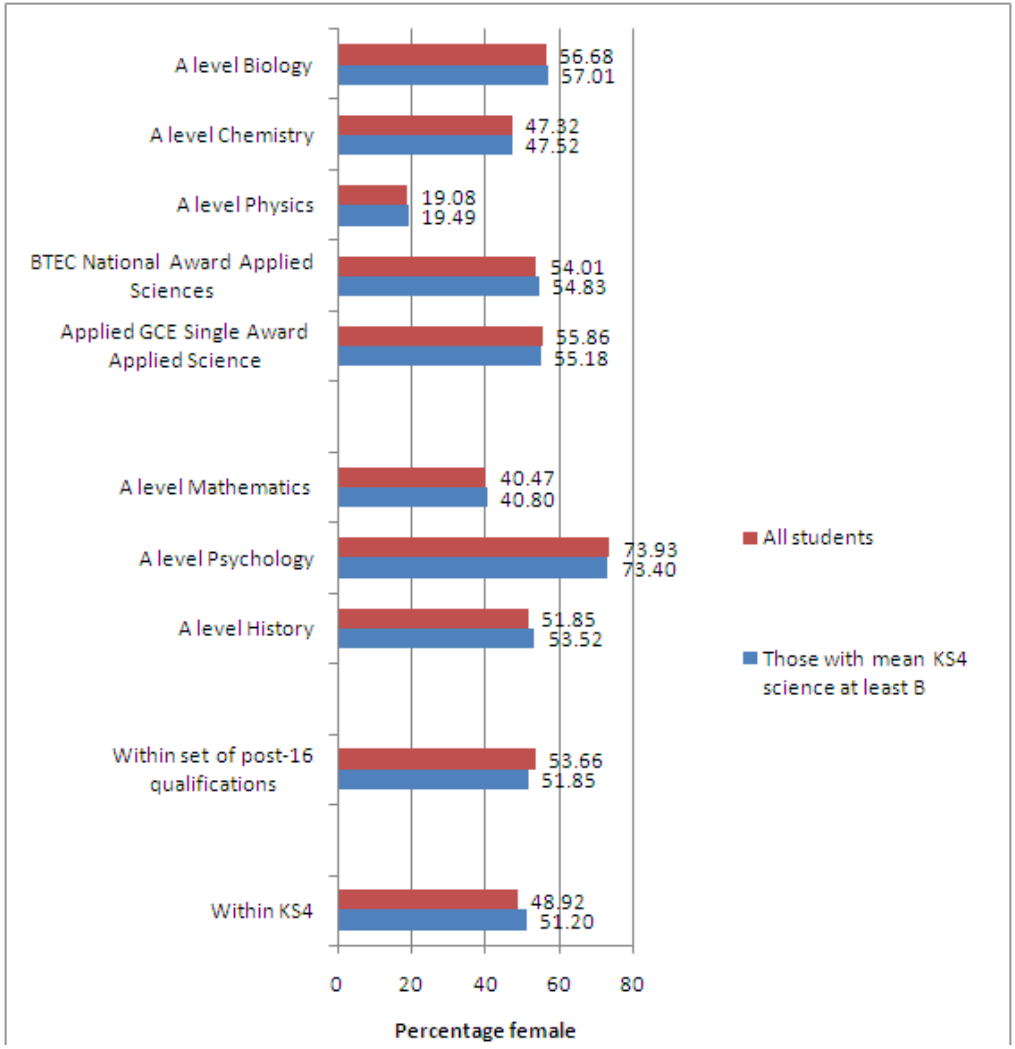
Problems with post-16 data

Our post-16 analysis is limited for two main reasons:

- NPD AS data is problematic (~20% missing due to cashing/not cashing in issues) – fixed(?) in newest data
- As of Jan 2011, we only have one post-reform full A-level cohort of data – hence it is probably too early to see longitudinal 'impacts' of the reforms on post-16 participation and attainment.
- However, can investigate first post-reform cohort...(KS4: 06-08, A-Level 2010)
- Work in progress…

GENDER: Participation in A-levels etc

Percentage of female students within select A-levels



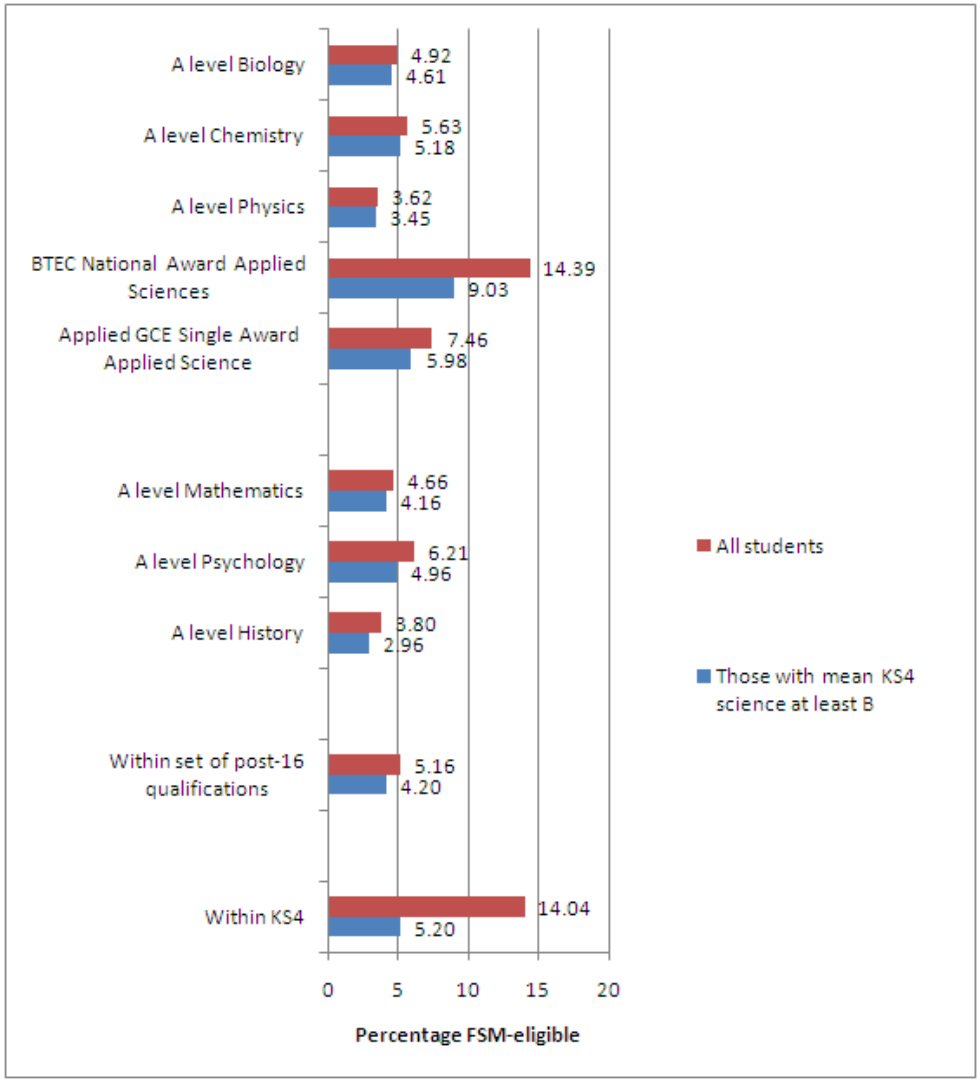
Main messages

- E.g. Not sure if the 'applied' A-levels are sufficiently 'there' in the data.
- Wide variation in participation rates across both sciences and non-sciences – e.g. biology/physics, maths/psychology
- The role of KS4 attainment – it certainly does not account for the differences.
- More later…

(first post-reform cohort: KS4 06-08, A-level 2010)

FSM: Participation in A-levels etc

Percentage of FSM-eligible students within select A-levels



Main messages

- Wide variation in participation rates across both sciences and non-sciences
- What is the role of KS4 attainment?
- Controlling for prior attainment indicates that FSM students are less likely to participate but this is not a 'science' problem *per se*.
- More next slide…

(first post-reform cohort: KS4 06-08, A-level 2010)

Influences on A-level participation – logistic regression modelling

Predictor	A-level		
	Biol.	Chem.	Phys.
Pseudo r-squared	0.391	0.435	0.423
Gender (female)	1.50	0.89	0.17
FSM (eligible)	1.08	1.62	0.87
KS4 mean points	1.21	1.27	1.26
KS4 course (TA cf. DA)	2.22	2.62	2.30
KS4 course (DA cf. Other)	4.69	4.17	3.75

Coefficients are odds ratio of participating compared to not.

All significant at 5% level – admittedly problematic

Routes into post-16

- There is an ongoing debate about the entitlement to Triple.
- Tension – more science versus 'broad and balanced curriculum

Main messages

Across the main sciences there are

- Large gender differences
- Large FSM differences
- More likely to progress from TA

KS3/4 to A-level value-added – TA versus DA

Using OLS regression to model A-level outcomes

Predictor	A-level		
	Biol.	Chem.	Phys.
(R-Squared)	41%	35%	38%
Mean KS4 points	7.1	7.7	8.3
KS4 course (DA)	-9.8	-8.7	-10.0
Gender (Girls)	5.3	1.3	-6.6
KS3 fine level	9.6	-0.1	9.8
FSM	2.7	4.7	2.1

Coefficients indicate change in KS5 outcomes (i.e. A-level points) for a unit change in predictor.

Shaded= significant at 5% level – again problematic

Main messages

- KS4 performance most important predictor
- KS4 course important - ~ TA10 point more (~ third of an A-level grade) for same mean KS4 attainment
- Girls make more progress in biology and chemistry but less in physics
- KS3 has some impact above and beyond KS4
- Socio-economic status - FSM students make more progress

EISER NPD-related FINDINGS Influences on participation and attainment	RELATION TO POLICY
KS4 • Increasing diversification of KS4 science participation • Some courses have better 'value-added' attainment ***Gender*** • Under-representation at KS4 of girls within 'high status' Triple Award, even when controlling for prior attainment – but evidence of move towards parity • Key influence on post-16 participation, even when controlling for prior attainment • Evidence of differential value-added attainment in A-level ***SES*** • Under-representation at KS4 of FSM students within Triple Award, even when controlling for prior attainment. • Negative effect on value-added attainment at KS4 • Some negative influence on post-16 participation when controlling for prior attainment – both science and not. • Evidence of positive value-added effect on attainment in A-level ***Progression to Post-16 science (ongoing)*** Triple award has higher progression rates to post-16 and higher outcomes (but Dual remains important in absolute number terms).	• Risk of losing the diversity of KS4 provision in the review and other changes (Ebacc/GCSE 'equivalence') • Recognise tension between providing flexibility and increasing stratification by social class. • Monitor and publish trends – gender and FSM • Encourage girls that science is also for them, particularly post-16 physics. • Enhance (prior) attainment of FSM students. • Work to establish distinct routes with 'equivalent' access to HE/employment. • Examine the longitudinal impact on progression/attainment/value-added of the 'push' for TA

Finally…

- The NPD is undoubtedly very useful in terms of assessing the macro picture following reform
  - particularly where the ecology is ‘rich’
- However, this sort of work needs to be augmented by other approaches to find out what (and the why) is going on in schools, attitudes to the reforms…
  - mixed methods – e.g. our (other) work shows that some teachers are still working out their views and responses 5 years on…a lesson for policy makers.

References

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- Homer, M., Ryder, Jim & Donnelly, J., 2011*. The use of national data sets to baseline science education reform: exploring value-added approaches*. International Journal of Research & Method in Education, 34, pp.309-325.
- Ryder, J; Banner, I. (2011) Multiple aims in the development of a major reform of the national curriculum for science in England In: *International Journal of Science Education* 33 (5) pp. 709 – 725

Thank you – questions?

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