Does greater exposure to science at secondary school encourage more young people to study for degrees in STEM subjects? **Marta De Philippis** assesses the impact on university enrolment and graduation of an educational reform in England in 2004 that entitled higher ability school students to take the so-called 'triple science' course.

Studying science: the impact of school curriculum on degree choice

Are school students in the UK making GCSE choices that hold them back for the rest of their lives, as some policy-makers claim? Do students in secondary schools focus too much on arts and humanities and not enough on sciences and mathematics? Does this prevent them from enrolling in more technical degrees with greater earnings potential after university?

Subject choice at university is extremely important in determining lifetime earnings. For example, in the United States in 2009, the wage gap between the average electrical engineer and someone with a degree in education was almost identical to the wage gap between the average college graduate and the average secondary school graduate (Altonji et al, 2012). What's more, studying engineering may be an even better investment than going to Harvard (James et al, 1989).

Policy-makers around the world are investing a very large amount of funds to encourage more graduates in science, technology, engineering and mathematics (STEM) subjects. But they continue to claim that the current supply of STEM skills is insufficient and presents a potentially significant constraint on future economic activity.

The policy debate mentions many possible factors to explain the lack of STEM graduates – for example, students' preferences, expected earnings, skills or self-confidence. Economic research suggests that students actually tend to have realistic beliefs about the returns to STEM subjects and that they do not react much to changes in expected earnings (Beffy et al, 2012). Moreover, students tend to enter university being over-confident – not under-confident – about their ability in science (Stinebrickner and Stinebrickner, 2014).

Other research finds that there is a large unexplained heterogeneity in secondary schools' effectiveness in developing talents in technical subjects like mathematics (Ellison and Swanson, 2012). This leaves considerable scope for policies that can improve the quality of secondary school education, one obvious candidate being to change the curriculum offered.

My research explores whether more exposure to science in secondary school encourages students to enrol and graduate in STEM degrees at university. Tweaking the subjects offered may be an effective way to intervene. While preferences and innate ability may be difficult to shape, it is easy to intervene in the design of the secondary school curriculum. And in contrast with other policies, such as trying to make changes in the composition of young people's peer groups, this is not a zero-sum game: everybody may potentially benefit from a well-designed curriculum.

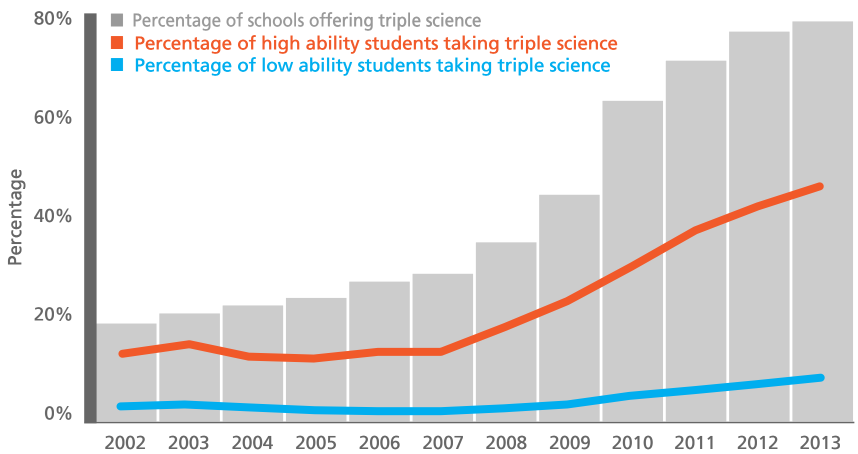
I analyse the effect on university outcomes of introducing an advanced science course in secondary schools in England: the so-called 'triple science' course, which requires students to take one full GCSE exam in each of biology, chemistry and physics rather than only two exams. In particular, I consider the effect on the degree course chosen and the probability of graduating in this course.

In 2004, the UK government introduced an entitlement to study triple science for higher ability students at age 14, with the explicit aim of fostering enrolment in post-secondary science education. This resulted in a strong increase in the number of schools offering triple science: from 20% in 2002 to 80% in 2011.

As a consequence, the share of students taking triple science increased from 4% in 2002 to 20% in 2011, an increase that was almost entirely concentrated among higher ability students (see Figure 1). Among students who were in the top 30 percentiles of the primary school grades distribution, the increase was around 35 percentage points: from 15% to about 50%.

But a simple comparison of university outcomes of students taking and not taking triple science would be misleading.

Figure 1:
Share of schools in England offering 'triple science' and take-up by high and low ability students



Source: National Pupil Database; high ability students are those in the top 40% for average English, mathematics and science primary school grades, low ability students are those in the bottom 60%.

This article summarises 'STEM Graduates and Secondary School Curriculum: Does More Exposure to Science Matter?' by Marta De Philippis, CEP Discussion Paper No. 1443 (http://cep.lse.ac.uk/pubs/download/dp1443.pdf).

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Those taking triple science may already be different along many dimensions and it would be inaccurate to attribute all differences in university performance to the triple science course.

I therefore focus on 14 year olds whose school did not offer the triple science course when they had enrolled at that school at age 11. I compare those in schools that subsequently (because of differences in timing of the policy adoption) introduced the triple science course and those in schools that did not.

In this way, I compare two groups of students, *a priori* identical because they all applied to the same type of schools – those not offering triple science – but *ex post* different because some were unexpectedly exposed to the option of taking the triple science course.

I find that taking triple science at age 14 increases the probability of choosing science as a subject for testing at age 16 by five percentage points. It also increases the probability of enrolling in a STEM degree at university (narrowly defined to include the pure natural sciences, technology, engineering and mathematics) by about two percentage points. This is a very sizeable effect, given that the share of STEM students is 13% of those going to university in England.

I also find that taking more science courses at secondary school not only encourages more students to enrol in STEM degrees, but it also increases the likelihood that they will graduate in these degrees. I estimate that the 2004 policy contributed almost one third of the increase in the share of STEM graduates in England between 2005 and 2010.

The effect on STEM degrees (in its narrow definition) is entirely concentrated among boys. One might think that stronger secondary school science preparation should affect girls more than boys, girls typically being less confident about their ability and more risk-averse. But the gender gap in STEM subjects widens because of this policy.

The difference between (very highly skilled) boys and girls does not arise in the take-up of the triple science course at age 14, since boys and girls at this stage select into triple science in the same proportion. The difference arises later on, at university, when subject choice is more related to occupations and jobs.

At university, both boys and girls are encouraged by the triple science course to take more challenging courses on average. But girls still choose more female-dominated subjects, such as subjects allied to medicine, instead of pure STEM degrees like engineering, physics and mathematics. This suggests that job characteristics play a very important role in the choice of subjects at university, with women and men displaying very different preferences, even at the very top of the ability distribution.

My results have important policy implications. First, governments should pay careful attention to the structure of their secondary school curriculum: working on an optimally designed curriculum may help to address apparent mismatches and market frictions in the supply and demand for skills.

Second, when it comes to choice of university subjects, there are other elements much more related to actual future jobs and occupations, such as preferences for job attributes, which are very relevant. Modifying preparation in science or mathematics at school may not be enough to shrink gaps related to more structural and cultural factors.

Taking more science courses at school encourages students to enrol in STEM degrees

Further reading

Joseph Altonji, Erica Blom and Costas Meghir (2012) 'Heterogeneity in Human Capital Investments: High School Curriculum, College Major, and Careers', *Annual Review of Economics* 4(1): 185-223.

Magali Beffy, Denis Fougère and Arnaud Maurel (2012) 'Choosing the Field of Study in Postsecondary Education: Do Expected Earnings Matter?', *Review of Economics and Statistics* 94(1): 334-47.

Glenn Ellison and Ashley Swanson (2012) 'Heterogeneity in High Math Achievement Across Schools: Evidence from the American Mathematics Competitions', National Bureau of Economic Research Working Paper No. 18277.

Estelle James, Nabeel Alsalam and Joseph Conaty (1989) 'College Quality and Future Earnings: Where Should You Send Your Child to College?', *American Economic Review* 79(2): 247-52.

Ralph Stinebrickner and Todd Stinebrickner (2014) 'A Major in Science? Initial Beliefs and Final Outcomes for College Major and Dropout', *Review of Economic Studies* 81(1): 426-72.