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School of Applied Social Sciences

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Do STEM schemes work?

Assessing the impact of STEM enrichment and enhancement activities on improving educational outcomes

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Introduction

In United Kingdom, as in virtually every developed country (US Stem attrition report, 2014), it is widely accepted that more people studying and working in science, technology, engineering and mathematics (STEM) at all levels are required (Garnham, D, 2011). This is because STEM skills are valued by almost every sector in the labour market and are very important for the nation's economic growth. . The Royal Society (2005, 2006, 2008, 2011, and 2012) however, expressed serious concern over the insufficient conversion numbers of 16-19 year olds studying science and mathematics into STEM graduates. This was an important determinant of STEM skills in the UK population. It was thought there would not be enough people with these skills to support the growing national STEM demands. Encouraging young people to take up STEM learning trajectories thus became a priority (Conway, 2009; EHRC, 2009, Ofsted, 2011) education policy during the last decade. To attain this goal, policymakers targeted STEM attrition in schools, with the rationale retaining more students in science and mathematics in secondary school is a low-cost, fast way to produce STEM professionals that the nation needs. A range of STEM enrichment and enhancement activities were introduced through the informal education sector. These were implemented to bridge the gap between science and maths as done in classrooms to STEM as done in the real world. Complementing learning in the formal education sector these hands-on activities worked with the objective of improving pupil understanding of STEM subjects while also encouraging young people to continue studying in these learning trajectories.

The need for this evaluation

The STEM Mapping Review (2004) conducted for the UK Government revealed over 470 STEM initiatives established by the then Department for Education and Skills (DfES), Department of Trade and Industry (DTI) and external agencies (Wynaczyk, 2008; Wynarczyk and Hale, 2009). Analysing 70 on-going government funded initiatives, the STEM Cross-Cutting Programme (2006) advised '...the need to rationalise Government supported initiatives and build on the best ones so as to achieve better results for the same amount of money' (DfES, 2006a, p.3).

STEM Education budget, initiatives and schemes have incessantly increased since then. However, major studies or surveys of part-taking schools and students, looking at the short term or long term impact the schemes have in improving take up, performance and achievement in STEM subjects is relatively scarce.

Thus despite having implemented these schemes funded by the government, private and educational charities since the start of 2000 we still do not know what works. This is because there haven't been many large scale evaluations assessing the impact of these enrichment and enhancement activities. This research project is one of the first few evaluations of the impact of these enrichment and enhancement activities in improving education outcomes for all pupils. The study also considered whether disadvantaged pupils gained any better in terms of making more academic progress or continued post-16 STEM participation as a result of engaging in these activities.

The research project

Science and mathematics form a compulsory part of the school curriculum for 11-14 year olds till the end of General Certificate of Secondary Education (GCSE), a nation-wide exam taken by 14-16 year olds in England. Thereafter, a subject- choice needs to be made. Attempts to increase participation clearly address concerns over the dropping post-16 participation rates in STEM (Osborne, 2003, 2007). While this is extremely important, it could be argued that, this knowledge economy might create greater social and economic polarisation, between those in relatively well paid, secure knowledge related occupations and those in lower skill jobs.

A positive way of dampening this anticipated polarity could be by motivating students from disadvantaged backgrounds to participate in STEM education.

This research project thus looked at the impact of these activities on improving attainment, increasing as well as widening participation. Gender, ethnicity, poverty, disability and prior attainment have all been linked to STEM attrition. Amongst the various social groups that shy away from science and maths the largest share is that of pupils from families living below the poverty line.

This study answers four key questions

1. Which factors are linked to underachievement of young people in science and maths in schools?
2. Can STEM Initiatives outweigh these barriers to participation in STEM education?
3. How effective have the STEM enrichment and enhancement activities been in improving attainment of participating schools and pupils?
4. Do equally qualified students from different socio-economic backgrounds follow similar learning trajectories after being exposed to similar STEM Initiatives?

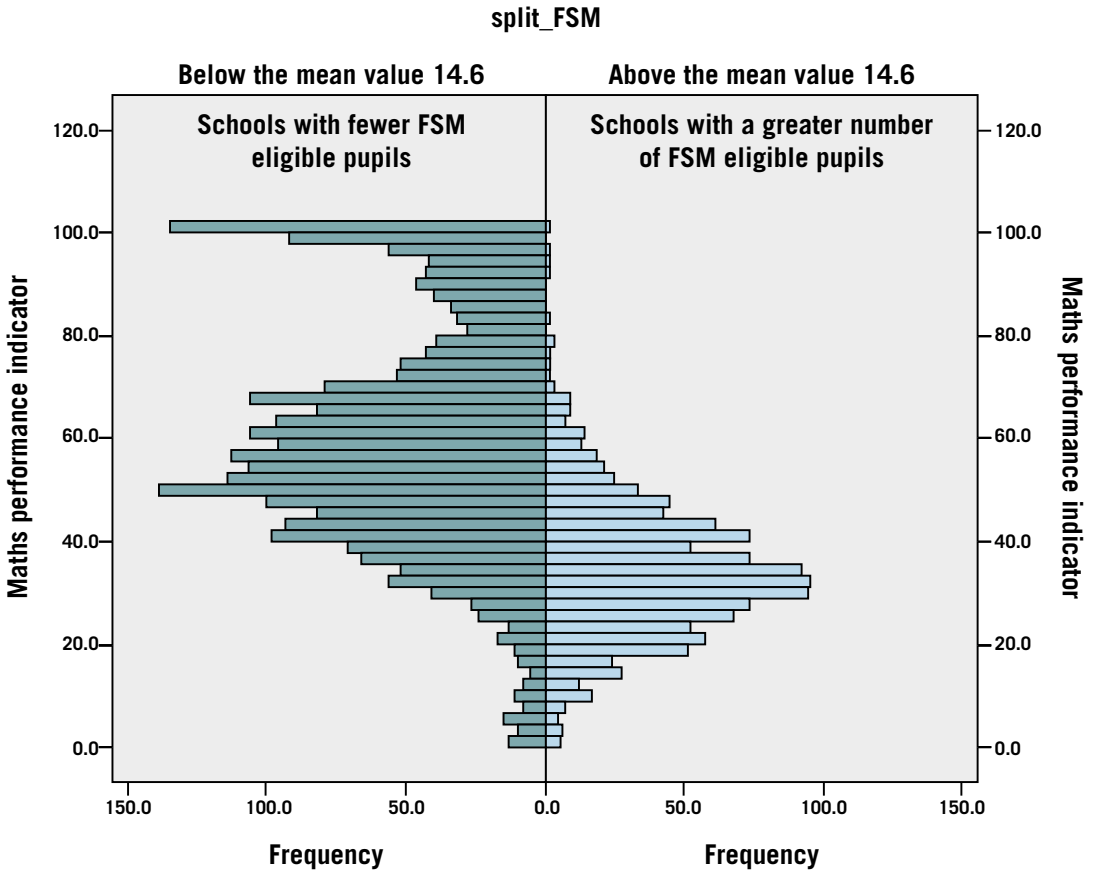
Evaluation methods

Making use of secondary government datasets in the form of National Pupil Database (NPD), this project set out to understand if schools or pupils engaging in these enrichment and enhancement activities had better educational outcomes than others. The two main criteria used to estimate educational outcomes were school performances in GCSE science and maths, pupil attainment in GCSE science and maths, and continued participation of young people in STEM learning trajectories at AS/A level.

A thousand intervention secondary schools and 80,000 students engaging in these programmes were followed-up from the beginning of key stage-3 to A-level (2007 to 2014). The study also used two deprivation measures a lower socio-economic class (indicated by eligibility for free school meals, FSM) and ethnic minority status to assess the impact of these initiatives on widening participation. Correlation and regression analysis was conducted and a range of effect sizes were estimated for this longitudinal study.

Results

The analysis conducted showed that overall science and maths results have been slowly and steadily improving for all schools and pupils in England. However, this success cannot be attributed to STEM enrichment and enhancement activities. This is because the improvements are not peculiar to schools or pupils known to have been involved in STEM interventions. Similarly, intervention pupils from lower socio-economic class and ethnic minorities did not attain any higher than the comparator or opt for STEM learning trajectories after engaging in these activities to a greater extent than the comparator. A bigger determining factor for the percentage of students achieving a grade C or above in science or maths in schools was the percentage of children from lower socio-economic class as seen in the figure below. An attitudinal scaling survey administered for another project showed these activities did not affect pupil attitudes towards science subjects.



Implications for policy and practice

These schemes are delivered at the local and national level for registered schools through STEM clubs, STEM networking events, science weeks, school visits and outreach programmes. These STEM enrichment and enhancement activities are being run to address a very important concern and their value cannot be undermined.

However, they call for huge investment of resources in terms of personnel, time and money. STEM skills are important but if these schemes do not work clearly the money could be spent elsewhere to support the national STEM agenda. It is also crucial to understand whether some of these schemes work better than the rest. It may then be possible to achieve better outcomes with similar or reduced levels of expense.

Synthesising 771 research reports, the systematic review conducted for this research project identified a range of individual, social, family and school related factors which interact to hold back a child from reaching their full academic potential. Several programmes have been implemented in other developed countries which could be tried in the UK. For more detailed discussions of the research findings of this project please contact the author.

Summary

Expert skill sets in areas of science, technology, engineering and mathematics in the population are deemed crucial for economic growth and progress. The government spends a lot of money trying to encourage young people to pursue STEM learning trajectories and careers. What policies ensued and how successful have they been?

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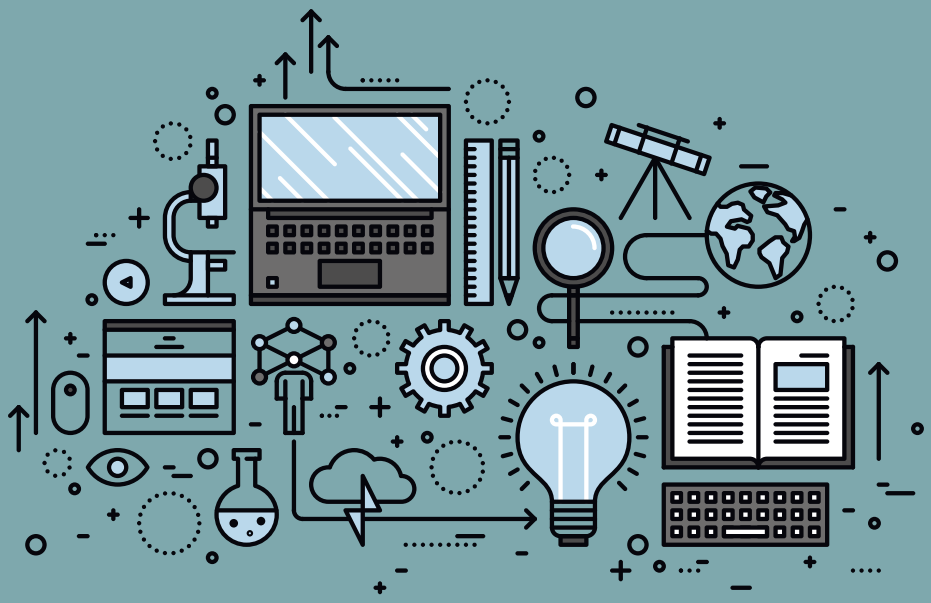

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Please cite the document as:
Banerjee, P.A (2016) Do STEM schemes work? SASS Research Briefing Document number 15, Durham University

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