University of Bristol Graduate School of Education and University of Bristol School of Mathematics: *November 2016*

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Overcoming barriers to student achievement in mathematics through teachers' action research

Introduction and background

This project, run jointly by colleagues from the University of Bristol School of Mathematics and the Graduate School of Education, looked at ways in which teachers can raise attainment in GCSE mathematics and thereby increase the access chances of more disadvantaged pupils.
It is a well-documented fact that students from more disadvantaged backgrounds in the UK perform less well at school and are under-represented in Higher Education (HE), particularly in the more selective universities. A relatively recent study has shown that, of those pupils eligible for free school meals (FSM), 14 per cent participated in HE compared with 33 per cent of their non-FSM peers (Chowdry et al. 2013). Whereas much attention is paid to the role of universities in widening participation, research suggests that poor pupil achievement at GCSE level is one of the strongest drivers of inequality in HE participation. Although GCSE scores have risen over time, pass rates in maths GCSE still trail the pass rates for other subjects by around 5 per cent. This means that in a subject which already has weaker pass rates, disadvantaged students may lag even further behind.
Bristol, where this research project was carried out, is a highly diverse city with some of the most affluent and some of the poorest neighbourhoods in the country. Between 2010 and 2013, pupils in state-funded schools in Bristol achieved below the national average pass rate in the mathematics component of the EBacc. There was a large gap between the school with the lowest proportion of disadvantaged pupils, where 85 per cent achieved grade A*-C in maths, and the school with the highest proportion of disadvantaged pupils where the corresponding figure was just over 40 per cent. There is no doubt that a failure to secure a good pass in maths at GCSE will be a barrier to pupils wishes to progress to HE, since the vast majority of undergraduate degree courses in the UK require a Grade C or above for entry.

Key points

Research methodology

- Researchers worked with two cohorts of teachers, one throughout the academic year 2013-2014 and the other throughout the year 2014-2015. The teachers joined a collaborative group and undertook a unit of the MSc in Education (Mathematics Education) at the University of Bristol Graduate School of Education.
- Participants identified a range of barriers to mathematical achievement for students at risk of not passing GCSE mathematics. These included: students being placed in low attaining sets with no expectation that they would pass GCSE; lack of self-belief: lack of engagement; and a lack of ability to work independently.
- The teachers from both cohorts identified their own area of inquiry and developed an action research project that fitted with the needs and context of their particular school. Early meetings supported them in identifying an area for their research. Later sessions supported the finding of relevant literature and the planning of the 'actions' which they wanted to investigate.
- In some cases there was one loop of planning, implementing and evaluating a set of actions and in other cases there were several loops, with each informed by the previous one.
- Once the teachers had completed their Masters assignments, university researchers looked for common areas of classroom practice which had emerged. They decided to focus their case studies on three teachers whose work was aligned to the concept of 'doing higher level work than expected with a class', and whose classes were approaching GSCE examinations. Details of their action research is outlined in the following sections. Pseudonyms are used, except in the case of Vicki, who is a co-author of the report.

Vicki's story

- Vicki's initial concern centered on the fact that she re-visited the same topics each year, and although pupils appeared to understand what they had been taught, their ability to retain the information was low. This led to frustration and disappointment on the part of her pupils.
- By September 2013, Vicki's year 11 class had finished the syllabus for the GCSE Foundation Tier which would mean that they could achieve no higher than a grade C.
- Instead of preparing her pupils for the examination by simply revising the Foundation content, Vicki decided to introduce grade B Higher Tier material including Trigonometry, Cumulative Frequency and Quadratic formula. She realised that the introduction of these topics would reinforce the concepts needed for the Foundation examination. For example, she hoped that Trigonometry would cause the pupils to recall facts about triangles and consolidate their work with fractions and calculations.

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- The content was delivered at a slower pace than would be the case for a higher ability class, and the pupils were reassured that they would not have to sit the Higher Tier examination.
- Vicki compared student achievement on two mock Foundation Tier papers one taken in October and another in December, after the time spent working on Higher Tier content. Out of 12 pupils, 1 dropped a grade, 2 achieved the same grade, 5 improved by 1 grade and 3 improved by 2 grades.
- In her qualitative evidence, Vicki recorded the following significant exchange: 'The Special Education Needs Co-ordinator (SENCO) from the school came up to me and relayed a story of one of my students offering to help another in the Special Education Needs department. His comment was "that's alright; I'll help him because I'm doing grade A work at the moment!" For this pupil to make that comment spoke volumes of the impact this learning was having on the pupils and how much progress was being made.
- At the end of the project Vicki acknowledged what the research had taught her, namely: that the increased challenge had led to increased self-belief; and that it had been possible to successfully raise the level of subject knowledge with a year 11 class.

Adam's story

- Adam was aware that his pupils had procedural knowledge which would enable them to tackle a task from a given starting point, but that they lacked strategies on which to draw if the task was presented in a different context. They seemed to want to be 'spoon fed' and simply given steps and methods for tackling different examination questions. He was therefore keen to get his students thinking, to provoke conceptual knowledge and understanding.
- Like Vicki, Adam had a year 11 class with several low attainers. He also decided to teach his group Higher Tier content for a period of six weeks. His key aim was to shift his learners away from procedural knowledge: i.e. an ability to execute action sequences to solve problems, which is tied to certain problem types and is not generalisable. He wanted to move them towards conceptual knowledge, defined by Rittle-Johnson et al as 'explicit or implicit understanding of the principles which govern a domain and of the interrelationships between units of knowledge which govern a domain'.
- As Adam delivered the Higher Tier content, although pupil's knowledge remained largely procedural, there was pride on their part that they could do a Grade A question.
- Adam reported an incident where, in the course of an intervention class, one of his pupils was able to help another from a higher ability group. The reason for this was that his pupil was displaying the ability to transfer knowledge from one domain to another. Adam expressed it like this: 'it does seem positive, they seem to like it … as opposed to what they would have been doing and they do seem to be picking up random things. You assume stuff and they just seem to do it without [being] explicit'.
- Adam gave his class a mock GCSE paper at the beginning and at the end of a six week period. In contrast to Vicki, he decided to give the pupils a Higher Tier paper at the end of the six weeks, reassuring them by explaining in advance that there would be some questions which they would not be able to do, and they should just attempt those with which they felt comfortable.
- Ten of Adam's pupils took both mock papers. Two of these pupils achieved the same grade on both and one dropped a grade. However, four pupils went up by one grade, two went up by two grades and one went up by three grades. In Adam's school, a student who makes a grade of progress in a year is deemed to have made 'accelerated progress'.

Eleanor's story

- Eleanor's starting point was a realisation that her pupils were neither motivated nor resilient.
- After the initial first few discussion meetings, Eleanor decided that she, like her peers, would focus her action research on her low achieving year 11 and year 10 classes and that she would break with the school's scheme of work and deliver Higher Tier content.
- Eleanor discovered that through teaching higher grade content such as Pythagoras' Theorem or factorising quadratics, her pupils had an engaging context for much of the content which they would need for the Foundation Tier examinations. This was the case even when they did not end up being able to 'do' Pythagoras' Theorem or factor quadratics.
- Eleanor's pupils reported that engagement with Higher Tier topics had increased their confidence and that they felt pleased with themselves. They also benefitted from engaging with work which was not simply a repetition of the work which they had done lower down the school.
- Eleanor's action research convinced her of the power of engaging students in work beyond the grade level of the examination for which they would be entered.

Conclusion

- The work reported here gives further evidence of the power of action research as a mechanism to support teachers' continuing professional development. It demonstrates the importance of meetings of a collaborative group for peer support, challenge and enrichment. For example, Eleanor's project was influenced by the work of others and she in turn influenced others through her own research.
- In the context of the suggestion that students from low socio-economic backgrounds may be excluded from opportunities to succeed in mathematics (Sutherland, 2014), the results of this project are significant.
- There is evidence here, albeit based on the experience of just three teachers, that if students with low prior attainment are offered activities and topics usually reserved for their higher attaining peers then several things can happen. Students can recognise their teachers now seem to believe they are capable of 'A' grade work. Students can report an increased belief that they can attain the key benchmark grade (in terms of access to Higher Education) of a 'C' at GCSE mathematics. Students' attainment can rise (as measured either by their success on that higher level content or on the content at which they had previously failed).
- The differences observed in student behaviour do not appear to be strongly linked to changes in the way they were taught, nor to shifts in the teachers' own mathematical knowledge or understanding. Although there were some minor shifts in methodology, all teachers commented on how little they changed their overall teaching strategies.

Further information about the project can be found at:
http://www.bristol.ac.uk/education/research/publications/GSoE-policy-bristol-briefings/
Alternatively you can find out more about the project from alf.coles@bristol.ac.uk