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Overcoming the mathematical barriers to participation in Higher Education

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Aims

The Bristol-based research project had the following aims:

1. to understand the role that GCSE mathematics plays in terms of access to HE

2. to work in partnership with mathematics teachers to raise attainment in GCSE mathematics

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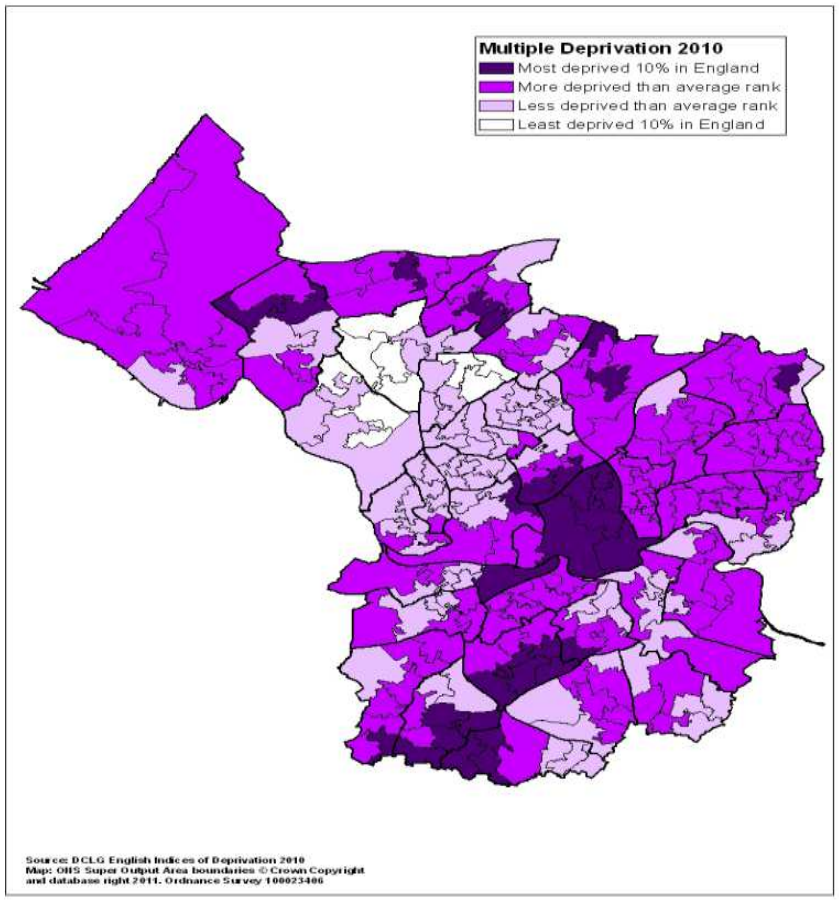
The City of Bristol

Bristol contains some of the most affluent and poorest neighbourhoods in the country.

Very high levels of deprivation exist in the South of the City, in the inner city and along the Northern boundary.

By contrast a large region in the North of the city consists of communities that are amongst the least deprived 10% in England.



Education in South Bristol

Education in South Bristol

- 18% in Bristol South progress to HE, compared with 50% In Bristol West
- Bristol South is 532nd out of 533 in league table of young people's participation rates in HE
- Post 16 educational opportunities in South Bristol are very limited by comparison with North Bristol
- Although young people in South Bristol may want to progress to University they lack the necessary know-how and know-who related to achieving this

Merchants' Academy

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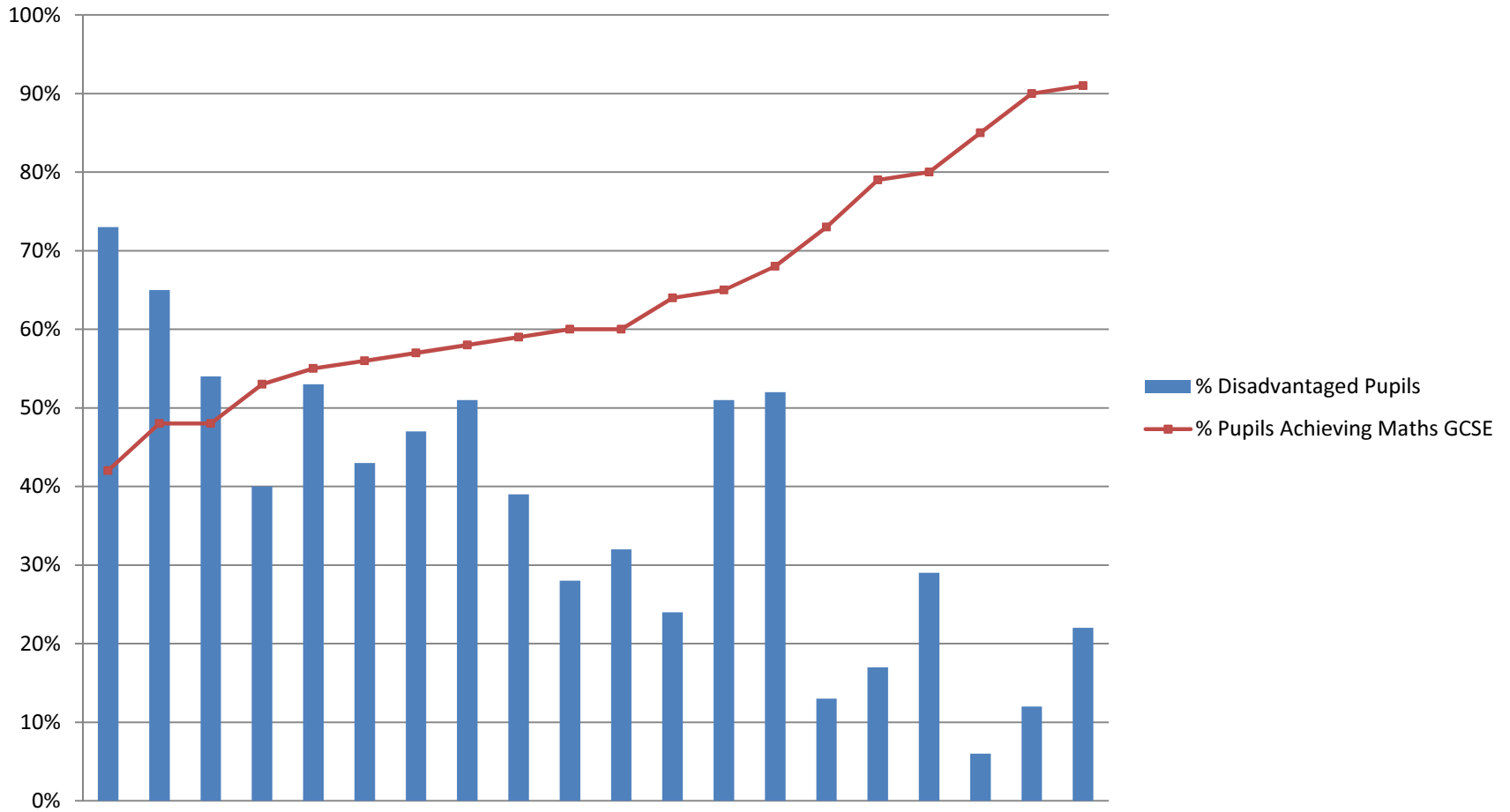
Bristol Schools GCSE Mathematics Results plotted against the proportion of 'disadvantaged pupils' in that cohort (2013)



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GCSE Mathematics and Access to University

The majority of degree courses require at least GCSE grade C in mathematics. The exceptions tend to be Arts and Humanities courses at Post-92 universities.

In Bristol, less than 50% of students in the majority of schools located in the poorer areas of the city achieve this qualification, compared with more than 85% of students in schools situated in more affluent areas.

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Educational achievement and Access to University

A recent study has shown that, of those students eligible for free school meals (FSM), 14% participated in higher education compared with 33% of their FSM-ineligible peers (Chowdry et al. 2013).

An independent school student is 22 times more likely to attend a Russell Group university than one from a state-funded school (Sutton Trust 2010).

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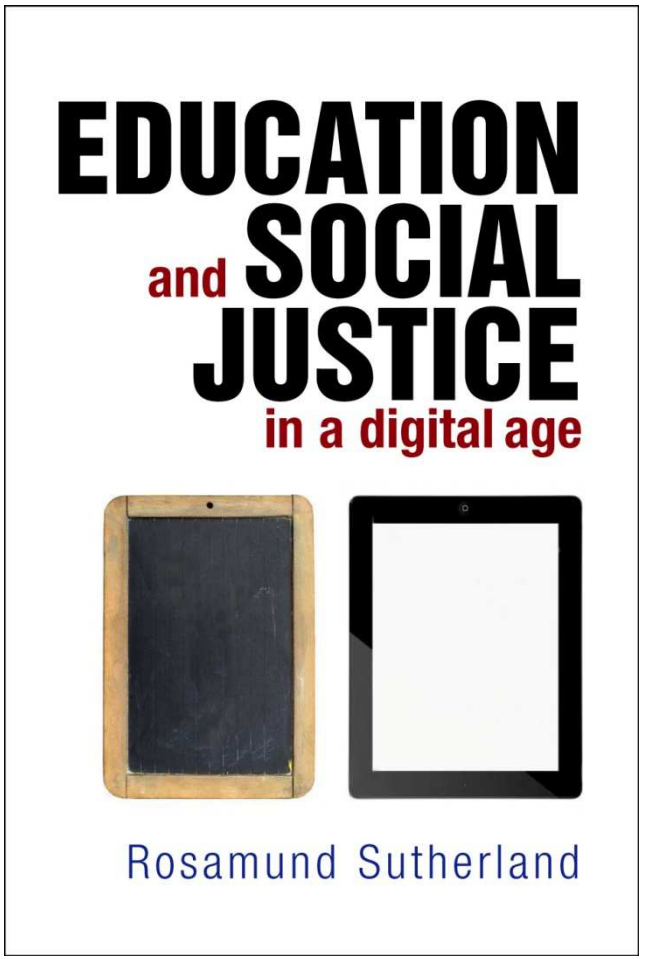
A Double Divide

"I am horrified by the contrast between the relatively privileged state comprehensive education of my own children and the education of very many young people in South Bristol.

This is not a difference between state and private education systems, but a difference between state schools in areas that are mostly attended by students from working- class backgrounds and state schools that are mostly attended by students from middle-class backgrounds.

The situation is even worse when we factor in the difference between the educational opportunities for those who attend private schools compared to those who attend state schools."
Sutherland, 2013



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Capabilities and opportunities to become

- Functionings are “beings and doings”— combinations of functionings are a person’s achievements.

- Capabilities are potential functionings— a person’s capability set represents their opportunity to choose between alternative combinations of functionings.

- A person’s capability set relates to their freedom to become and achieve.

(Sen, 2001, 2008, 2009)

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Capability and opportunity

Two girls want to become maths teachers. For one, despite attending an 'outstanding' state school in North Bristol, the reason for her low grade in GCSE maths was her decision to spend less time on maths and more time in the drama club and other leisure activities. For the other, from a school in one of Bristol's poorest districts, despite her interests in maths and school work, her results were due to her maths teacher leaving her school two terms before she took the GCSE examination.

(adapted from Walker and Unterhalter, 2007).

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Practical Action and Social Justice

Young people who live in poorer areas of Bristol are much less likely to have GCSE maths as part of their capability set than young people who live in more affluent areas.

The capabilities approach argues for the importance of experimenting with practical changes on the ground, and monitoring whether such practical steps are reducing or exacerbating social and educational divides.

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“I’ll help him because I’m doing grade ‘A’ work at the moment”: teachers’ action research to overcome barriers to student achievement in mathematics

Alf Coles, Richard Budd, Vicki Hitchins, Ros Sutherland, Laurinda Brown, Jeremy Rickard

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Collaborative group principles

(a) group size less than or equal to 10,

(b) meetings spread out over e.g., 5 months

(c) teachers from a range of schools and volunteers rather than conscripts,

(d) leader of the group sets up a loose structure for meetings and time is given to each participant to discuss their emerging thoughts about their issue,

(e) leader of the group gives individual readings in between meetings to support participants thinking about their issue … (Brown and Coles, 2011, p.865)

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Our methodological stance

In working with a small number of cases we are deliberately adopting an approach of 'particularization' (Krainer, 2011, p.47).

We draw out common themes in order to illuminate *possibilities for action*, rather than searching for general principles.

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Vicki's Story

Initial starting point

- school scheme of work does not allow for true independent inquiry – teachers end up re-teaching year after year (January 2014)
- I had subconsciously developed an almost resignation to pupils engaging during a lesson, yet not being able to retain and recall the learning and knowledge for the subsequent testing. I had almost separated the two parts of the process (learning and recalling) and grown to accept that as the way it normally would be (Journal entry).

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A ‘circular’ curriculum

- The lesson was a topic that had been covered before yet had not been previously mastered.
- The teacher perceives that the pupils need a different ‘hook’ to develop their learning.
- The pupils face a topic where they may have previously been successful but could not remember all of it. (And this leads on to the possibility they are struggling to engage because of disappointment/frustration at not being able to remember).
- The teacher is trying to find yet another way of teaching a topic that should have been covered before yet needs to be done in a different way so pupils remain focused & hopefully have something that will remain in their understanding.

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What Vicki did …

From October to December the pupils received a grade B Higher Tier diet including Trigonometry, Cumulative Frequency and the Quadratic Formula. I decided that the topics would … reinforce the concepts needed for parts of the GCSE Foundation course. Trigonometry, for example, would hopefully cause the pupils to recall facts of triangles and consolidated their work with fractions and calculations. (Final assignment)

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. . .

- The pace was slow compared to how I would teach these to a higher ability group. It took double the usual time as usual to teach but there was the flexibility within the structure this year for this to happen … they were being told regularly that they were doing aspiring grade A/B work. (Final assignment)

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Mock exam results

Pupil	M/F	Target Minimum Grade (TMG)	October Mock Result	December Mock Result	Difference in grades (Oct to Dec)
1	M	F	U	G	+1
2	F	E	F	F	0
3	M	E	F	E	+1
4	M	D	G	E	+2
5	F	E	F	E	+1
6	F	E	E	absent	
7	M	G	U	G	+1
8	M	G	F	G	-1
9	M	E	G	E	+2
10	M	C	E	D	+1
11	M	E	E	E	0
12	M	D	G	E	+2

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Some common themes

- The changes in this project did not come about through major shifts in *how* these teachers taught, nor in their mathematical knowledge …

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Teachers' perceptions of students

- '[m]y expectation of what pupils can achieve has increased' (Vicki)
- Adam was surprised at what his students retain, after starting on the Higher Tier work with them
- Eleanor went from thinking her year 11 class could not possibly get a 'C' grade, to thinking that her (equivalent) year 10 class could do.

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Students' self-perceptions

- 'they are believing they can get a grade C in Maths' (Vicki)
- '[s]tudents felt encouraged, if not surprised, that we believed they could be successful. They seemed proud to be able to do a 'grade A' question' (Adam)
- '[w]hen asked in the interview how they felt after completing C and B grade work they all said they were pleased with themselves and it gave them confidence to try more' (Eleanor).

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Concluding themes

- Through being offered Higher Tier mathematical topics and knowing they are able to do ‘A’ grade work, it appears students, within a matter of weeks, can experience changes in their view of themselves in relation to mathematics.

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Changes in self-perception

- We see these Stories as existence proofs, or, ‘paradigmatic cases’ (Freudentahl, 1981, p.135) of just how quickly it is possible for students’ perceptions of their own capabilities to shift, even students who have presumably experienced repeated failure within mathematics (for up to ten years).

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A building block subject?

- If there is an assumption that mathematical competence builds in a linear manner with solid ‘building blocks’ needed before any more complex work can be attempted (an assumption built into the new curriculum), we fear that students may end up still being offered the kind of ‘circular curriculum’ described by Vicki.

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A role for complexity?

- An implication we draw from the work of the teachers on this project, is a demonstration that each ‘link’ in a supposed chain of mathematical skills needed to access a particular topic does not need to be ‘securely in place’ in order to access that topic.
- Indeed, through working on more complex topics we have evidence that subsidiary concepts may be retained in an efficient and even surprising manner.

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Final thoughts

- Evidence of the influence of teachers' view of students on students' views of themselves as learners.
- Evidence of the power of collaborative action-research as a mechanism for teachers' professional development.

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Recommendations

1. On-going collaboration between school and university teachers is essential in order to tackle the gap in HE participation rates between different areas of Bristol.
2. Collaborative action research between teachers and researchers, as opposed to 'one-off events', should be prioritised as a means for tackling under-achievement in GCSE mathematics, in order to impact on the HE participation rate.
3. The message should be communicated, via free resources for schools, that Higher Tier GCSE topics can be offered to students at all levels of prior-attainment. This is in-keeping with the recent changes to the Mathematics National Curriculum and the emphasis on all students achieving mathematical mastery.