Economic Factors Behind Mathematics Achievement[1]

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Mathematics for some

> *Socio-economically advantaged students and schools tend to outscore their disadvantaged peers by larger margins than between any other two groups of students. (OECD, 2013a, p. 34)*

This is indeed a sobering thought that will no doubt cause controversy by its claim that it is economics, income inequality or social economic status (SES) which is more significant than gender and race in explaining differences in mathematics achievement. Whilst this will cause consternation, it is just obvious. Being a disadvantaged student does not mean you can't go on to do well, earn a salary significantly over the median wage, or even write an article for an international conference! While some students from disadvantaged backgrounds can succeed "*against the odds*" (Bembechat, 1998), the system leaves many where they are. Social mobility becomes the story of the few, not the many; history is written by the winners. But relatively few of us ex-poor kids do well, and in so doing, we leave many behind us. I wrote about this in my PhD thesis (Gates, 2000). In 1963 I took the 11+ as did my best mate, Tony. We both came from the same socio-economic background, but for some reason, I passed, Tony did not and after we left Primary school, I never saw Tony again.

> *"Kids who failed, I never met them again. We lived in the same town; we moved in different cultures. We were totally segregated." Colin Welland on TV Programme Grammar School Kids*

In "*Is* mathematics for all?" Gates & Vistro-Yu, (2003) argued that across the world indeed mathematics *wasn't* for all, but was differentially experienced. We suggested several strategies to help a process of democratisation of mathematics: detracking, equitable allocation of resources, and the appreciation of working-class cultures. Two decades later and we are still arguing for the same strategies, which begs the question – why? Something must be going on to sustain the levels of inequality within the teaching and learning of mathematics in the face of much apparent consternation and displeasure. What are we doing wrong, or rather not doing right? Or maybe, more sinisterly, is this inequality sustained because it is intentional and desirable.

I am going to start with a focus on the OECD analysis of PISA 2012 data and in particular what that throws up about poverty and achievement. One finding is that across OECD countries, a more socio-economically advantaged student scores the equivalent of nearly one year of schooling higher than a less-advantaged student (OECD, 2013a, p. 13).

What the PISA studies consistently show is that SES is very clearly associated with mathematics achievement in a number of complex ways, at the national level (through higher spending on education), the school level (through providing a safe environment and high-quality resources) and the individual level (through parental engagement for example) (OECD, 2013a, p. 37). However, what current economic and social analyses are showing is that it is not so much the existence of *poverty* that is the result of many social problems, but is the existence of – and the contemporary increase in – *income inequality* which lies at the root.

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[1] Adapted and expanded from Jurdak, M. et al. (2016) pps 23-27.

> *The highest-performing school systems are those that allocate educational resources more equitably among advantaged and disadvantaged schools and that grant more autonomy over curricula and assessments to individual schools. (OECD, 2014, p. 4)*

So, whilst the mathematics education research community might want to frame the debate on mathematics achievement around cognitive development, identity, curriculum, teaching style, cognitive loads, Direct Instruction or inquiry etc. we are up against a much bigger problem – the growing income inequality (Dorling, 2014).

> *A growing body of evidence points to high and rising inequality as one of our current decade's most important global issues in light of the far-reaching implications increasingly associated with it. (Stotesbury and Dorling, 2015, p. 1)*

This extent of the malignant effect of inequality has been well illustrated (Wilkinson, 2005; Wilkinson & Pickett, 2010) such that greater equality increased everyone's quality of life. But if we want social class to have less influence on educational (and therefore mathematics) outcomes, "*it will be necessary to reduce the material differences which are so often constitutive of the cultural markers of social differentiation*" (Pickett & Wilkinson, 2015, pp. 323-324). As mathematics educators therefore, we need to work to reduce the wealth of the affluent (particularly the new 1%) and distribute it to the poor. This will be a difficult process for many in the mathematics education community, yet is exactly what has been proposed by Ole Skovsmose, Rico Gutstein and Ubiratan D'Ambrosio – amongst many others – including Wilkinson and Pickett (2010, p. 108) for some time.

Drawing together data from a range of international sources, Stotesbury and Dorling (2015) have looked at the PISA data on mathematics achievement. Their analysis is suggesting two things. First that mathematical achievement is negatively correlated with income inequality (as measured by the ratio between the percentage of wealth owned by the top 10% and the bottom 10%), but second that this correlation is significantly stronger when we measure the maths ability of older (16-24) students. "*This is interesting because it hints at the possibility that more unequal countries' education systems fail to foster long-term understanding to the same extent that education in more equal countries appears to have a longer lasting effect on young peoples' ability*" (Stotesbury and Dorling, 2015). In other words, in countries with low levels of income inequality, what is taught in school mathematics seems to be retained longer once the student leaves the education system than where income inequality is higher.

That is a quite a surprising claim. How might a macroeconomic statistic on measures of relative wealth influence how students learn mathematics even after they leave school? Well, the PISA data would need to be mined in a lot more detail to uncover the causal mechanisms at work. Dorling's work, and that of Wilkinson and Pickett, points to a number of social characteristics of unequal societies – increased social conflict, anxiety and insecurity, levels of homicide, etc. and it is in there where we may find some of the root *causes* (but not the *manifestations*) of underachievement in mathematics.

In a study of mathematics education in "high performing" countries, Askew et al. (2010) argue that attainment in mathematics might be "*much more closely linked to cultural values*" (p. 12). This they admit "*may be a bitter pill for those of us in mathematics education who like to think that how the subject is taught is the key to high attainment*" (p. 12). Yet the way we respond to that may also be both cultural, and, importantly, political. Askew et al. argue that no system has the definitive answer; that choices need to be made between some very central social characteristics. So "*you can have an egalitarian education and high standards (Finland), or you can have a selective one and still have high standards (Singapore)*" (Askew et al., 2010, p. 14). The question is though, whose choice is it and how is that choice made? The economic and political system itself facilitates some choices over others. Yet as researchers we too have choices. The word "politics" does not appear in Askew et al. who prefer a focus on "*socio-cultural-historical backgrounds*". What Dorling, and Wilkinson and Pickett's work offers us, is a *different* choice of emphasis, that complements the focus on characteristics more visible in mathematics education. The single reference in Askew et al (2010) to "(social) class" (remember THE most significant characteristic according to the OECD) is restricted to a discussion of how parental social class in China is not a significant discriminator when looking at parental expectations. (See Gates and Guo, 2013 for a discussion of the influence of social class in British-Chinese student achievement).

Fig. 3.1 Income Inequality and 15 year-olds' maths ability

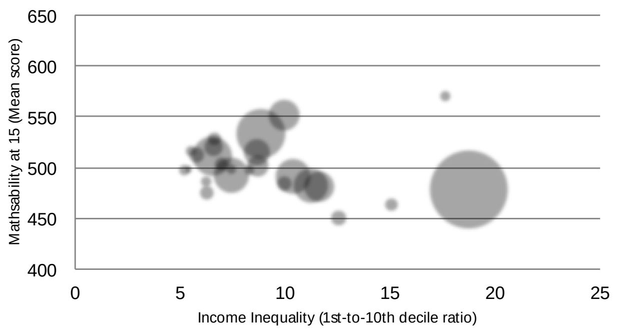
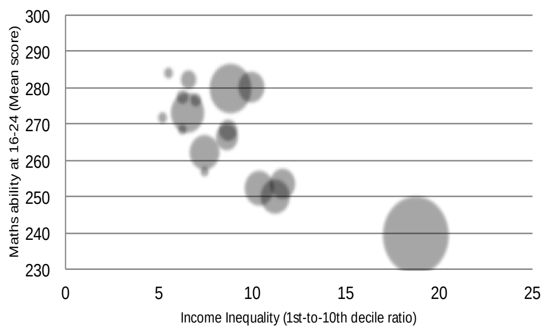


Fig. 3.2 Income Inequality and 16-24 year-olds' maths ability



But it does not have to be like this, "*countries do not have to sacrifice high performance to achieve equity in education opportunities*" (OECD, 2013a, p. 3), "*Mexico, Turkey and Germany improved both their mathematics performance and their levels of equity*" (OECD, 2013a, p. 26). The OECD analysis also illustrates that merely increasing expenditure on education will not bring about improvement in achievement if it is not accompanied by greater equity. It is not a matter of how much is spent, but on how it is spent

> *In particular, greater equity in the distribution of educational resources is associated with higher mathematics performance. 30% of the variation in mathematics performance across OECD countries can be explained by differences in how educational resources are allocated between advantaged and disadvantaged schools. (OECD, 2013a, p. 29).*

In highly differentiated educational systems, the impact of a students' socio-economic status on his or her educational goals is stronger than in less differentiated systems (Buchmann & Dalton, 2002; Buchmann & Park, 2009; Monseur & Lafontaine, 2012)

> *In highly differentiated systems, socio-economically disadvantaged students tend to be grouped into less academically orientated tracks or schools, and this has an impact on their educational aspirations, possibly because of the stigma associated with expectations of lower performance among students enrolled in these tracks and schools, or because less – and often poorer quality – resources are allocated to these schools.* (OECD, 2013b, p. 86)

Given the widespread use of social class segregation through "tracking" and "setting" in the organisation of mathematics classes, this effect is likely to be enhanced.

Mathematics isn't for all

We have experienced in mathematics education "*the social turn*" (Lerman, 2000) and the "*socio-political turn*" (Gutiérrez, 2010) yet both of these have tended to encompass largely a view of inequity as "*a problem affecting particular groups of people [rather than] a problem of the school system*" (Pais, 2014, p. 1086). As a result of an individualisation of failure, attention has been directed away from the economic system which by design creates inequality. It might also explain why the systematic failure of children from working class communities gets so easily overlooked, despite all the research that has explored this area for decades (Pais & Valero, 2012). I might go further – it is because of the "*depoliticisation* of research" (Pais, 2014, p. 1090) that allows much of mathematics education research to cast a blind eye to the most significant source of underachievement. One source of this depoliticisation is a tendency to assume, erroneously, that postmodern approaches offer insights because they "*move beyond Marxist views of power*" (Gutiérrez, 2010, p. 12). Given the immense power of Marxist analyses of the economy, such individuating constructs as discourse, identify and a focus on localised struggles, whilst locally useful, can only fail to grapple with the structural inequalities which are an inherent component of international capitalism.

As illustrated in OECD publications, internationally there is a long history of under achievement in mathematics illustrated by many young people not enjoying the subject and not taking up further study after compulsory schooling and the problem remains entrenched. One thing is clear - success at mathematics is not evenly distributed across sections of society. So to understand the differential performance of pupils from low SES backgrounds, we need to look into classroom practices to ask difficult questions about the experiences of learners from certain social-economic groups. Of course much literature in mathematics education talks not of social class, but of levels of attainment. Much literature in the field of mathematics education focuses on teaching and learning and on levels of pupils' attainment through a focus on the pupil, the classroom, the teacher, the curriculum, and the school – in other words on the localised manifestation of cultural practices. Fewer studies drill down into the very structure of the economic and political system exploring how it solidifies into the interactions and artefacts of mathematics education. This is an example of what Bourdieu calls *misrecognition* (Bourdieu, 1989, p. 377) where social power is exercised by making itself unrecognisable (Bourdieu, 1990) - and thus representing a denial of the economic and political interests at work.

There are though some robust examples of inquiries into social class. One such is Sarah Lubienski who studied mathematical experiences of pupils with an eye to looking at pupils' backgrounds (Lubienski, 2000a, 2000b, 2002, 2007). Whilst she naturally expected to find SES differences what she actual found were very *specific* differences in two main areas – *whole class discussion* and *open-ended problem solving*. These are two well-researched pedagogical strategies and classroom practices which at least in professional discourse are held in some esteem. Discussion based activities were perceived differently by pupils from different social backgrounds. High SES pupils thought discussion activities were for them to analyze different ideas whilst low SES pupils thought it was about getting right answers. The two groups had different levels of confidence in their own type of contributions with the low SES pupils wanting more teacher direction. Higher SES pupils felt they could sort things out for themselves – as their parents do in life presumably. I suspect this is not an uncommon feature of many schools but where does it emanate? Here then social class is a key determining characteristic largely absent from much literature on discussion based mathematics.

A second area where Lubienski noted differences was that of open-ended problem solving. The high level of ambiguity in such problems caused frustration in low SES pupils which in turn caused them to give up. High SES pupils just thought harder and engaged more deeply. It is well known that middle class pupils come to school armed with a set of dispositions and forms of language which gives them an advantage because these dispositions and language use are exactly the behaviours that schools and teachers are expecting and prioritise (Zevenbergen, 2000). High SES pupils have a level of self-confidence very common in middle class discourses whilst working class discourses tend to be located in more subservient dependency modes, accepting conformity and obedience (Jorgensen et al., 2014).

Middle class pupils after all tend to live in families where there is more independence, more autonomy and creativity (Kohn, 1983). Studies of parenting suggest different strategies are used in different class backgrounds. Low SES, working class parents are more directive, requiring more acquiescence. Middle class parents tend to be more suggestive and accommodating reason and discussion (Lareau, 2003). The middle classes grow up to expect to be and to feel superior with more control over their lives. Class is never far away from the mathematics classroom, but it is often far away from mathematics education research

The poverty of experience

One popular justification for learning mathematics is its usefulness and applicability to "*the real world".* Yet many young people experience mathematics from a very unreal world – the world of the school classroom. This world has specific rules, practices and objects all of which work insofar as they make school mathematics work as a system in and of itself. Pupils solve equations without ever having a purpose, other than to get a solution through applying a set of procedures in the correct order. The solution is not a solution to any real problem and it is questionable whether any of the procedures learned in school mathematics would solve any problem that young people encounter either as adolescent pupils or as young workers. In this way learners are *alienated* (to use a Marxist concept) from their learning. This was expressed very starkly in the Cockcroft Report 462 way back in 1982

> *Mathematics lessons in secondary schools are very often not about anything. You collect like terms, or learn the laws of indices, with no perception of why anyone needs to do such things. There is excessive preoccupation with a sequence of skills and quite inadequate opportunity to see the skills emerging from the solution of problems. As a consequence of this approach, school mathematics contains very little incidental information. A French lesson might well contain incidental information about France - so on across the curriculum; but in mathematics the incidental information which one might expect (current exchange and interest rates; general knowledge on climate, communications and geography; the rules and scoring systems of games; social statistics) is rarely there, because most teachers in no way see this as part of their responsibility when teaching mathematics. (Cockcroft Report, 1982, Para 462)*

Now of course school mathematics is school mathematics – and is experienced in a somewhat similar context by almost all pupils whatever their social background. However, what is different for different pupils is the form that school mathematics takes. Some pupils will remain within a somewhat abstract world where the systems of thought of the school will be exactly what they need to move onto a next stage – be it further study of mathematics or higher education. For others however, those whose trajectory will be moving more directly toward employment in some form, their school mathematics will be at odds with what everyone knows is needed to practice. Young people who move into employment move from one set of practices to another quite different set.

In a structural way this is no different from the workplace; there you find jobs to be done, manuals to help, tools to use, timescales to keep to, and a team of people to work with. Here however, they are often referred to as systems, tools, artefacts and protocols (Gagliardi, 1990). These became "*crystallised operations*" (Leont'ev, 1978) and the work activity not only structures the tools and artefacts, but becomes also structured by it (Pozzi et al., 1998). Recent work on workplace mathematics has shifted a focus away from a more conceptual, cognitive approach where we look to how school mathematics can be used in other settings, to a more situated and cultural approach (Hoyles et al., 2010; Roth, 2014; Williams & Wake, 2007a, b). Not only has this changed the way we see mathematics in use, but it has also contributed to a change in how we see mathematics itself. What we do now know is that school mathematics is quite different from workplace mathematics. Many young people coming from school fail to see the nature of mathematics as conventional and idiosyncratic when used to undertake practical tasks. Because mathematics is "shaped" by the workplace context, rather than procedural, this leaves them unprepared for tasks in which mathematics is embedded and functional.

Class, in some guise or another, is always a latent variable whose invisibility obscures possibilities for action. However this remains not merely an epistemic or empirical question, but a political and an ideological one. Engaging explicitly with class and social differences in learning has been shown to have the potential to open up greater opportunities for higher order thinking (Jorgensen et al., 2011), and for raising the intellectual quality of pupil cognition (Kitchen et al., 2007). However, if failure in mathematics is structured and systematic as the OECD seems to suggest, why is this not clearer in mathematics education research? That is indeed an ideological question. Pais and Valero (2012, p. 18) argue *"although many researchers acknowledge the social and political aspects involved in reforming mathematics education, they end up investigating problems as if they could be solved through better classroom practices"*, but changing school mathematics practices "*depends of course on changing the formal educational structures that determine and shape the particular mathematics education practice experienced by the students in their schools*" (Abreu et al., 2002, p. 4). If we are to change things, we have to more away from claiming as they do that such considerations are *"beyond the scope of this book"*.

We need to engage more with the consequences of the economy which structures our existence, our exchanges and our relationships. This might mean shifting away from a denial of grand narratives, and looking instead toward those structural explanations of the social world which have proved successful.

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