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Is the impact of SES on educational performance overestimated? Evidence from the PISA survey

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ABSTRACT

Despite a consensus that children's socio-economic status (SES) is linked to their educational outcomes, research is inconsistent. Differing variables are used to quantify SES; this can artificially boost its explanatory power. Policy-makers are encouraged to infer overly optimistic potential for redistributive tools. The PISA survey dataset was interrogated. The association between academic performance and two variables, parental educational attainment, and household income – was analysed. Results indicated that their link to academic performance was modest. Parental educational attainment was more important. Collapsing these into one single concept, rather than clarifying patterns of academic performance, concealed important differences between wealthy and poorer countries. The discussion proposes eschewing the unitary concept of SES.

1. Introduction

1.1. SES and educational outcomes – An axiomatic connection?

That social class plays a key role in influencing key outcomes in people's lives is axiomatic across the social sciences. Its importance in academic attainment is also widely accepted. For example, the OECD's influential Programme for International Student Assessment (PISA), a global survey of fifteen year olds' knowledge in core educational domains, includes measures related to children's socio-economic status. The analysis of the 2015 cycle (OECD, 2016) indicated that socio-economically deprived students were almost three times more likely not to attain baseline competence in key subjects compared to less deprived students. That report argued that "students' backgrounds continue to influence their opportunities to benefit from education" (2016; 202), and stressed the importance of ensuring that "the most talented rather than the wealthiest students [should] obtain access to the best education opportunities." (2016; 202). Older influential studies asserted a similarly strong link between SES and school performance: "the higher the SES of a student's family, the higher his academic achievement" (Boocock, 1972: 32). Similarly, Bowles and Nelson (1974: 44) asserted that "the effect of socioeconomic background on … [subsequent] schooling, income and occupational status is greater than the effect of childhood IQ." Bradley and Corwyn (2002: 388) argued that 'collective' or community SES should also be considered as an important, if complex, correlate of academic achievement.

1.2. Educational policy and SES differentials

Policy-makers also recognise the apparent threat to educational fairness and effectiveness caused by socio-economic differences between students, and frequently seek to remedy this by directing increased resources towards students from poorer backgrounds. One popular strategy is to lower the student-teacher ratio for poorer schools. For example, in a majority of OECD countries, schools with relatively high proportions of disadvantaged students have more full-time teachers (OECD, 2014). In the Netherlands, schools with more students "weighted" as disadvantaged are allocated more funds, and have on average 58% more teachers per students (Ladd & Fiske, 2009); France has a similar scheme (Benabou, Kramarz, & Prost, 2009). Sometimes the schools simply receive more funding where they take in a high proportion of economically disadvantaged children. In France, schools in deprived areas received 16% more funding per student than average, directed at teacher bonuses and supplementary staff (Moisan, 2011). Chile introduced a similar scheme (Brandt, 2010). A majority of OECD countries pay additional salary or bonuses to teachers working in disadvantaged areas. (OECD, 2014). Quota systems can also be used to try to ensure that schools include significant numbers of children from poorer backgrounds. Some regions in Belgium, the Netherlands and Spain require secondary schools to reserve a certain percentage of their places for students from primary schools that are ranked disadvantaged (Calero, 2005; Ladd, Fiske, & Ruijs, 2009). In Ireland, census data are used to identify disadvantaged schools, which are provided with

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additional funding to lower the pupil-teacher ratio, employ school-home liaison personnel, receive additional school equipment, enjoy additional access to remedial support schemes and school completion programmes (Department of Education and Skills, Ireland, 2011).

1.3. Problems with the SES assumption

However, this paper argues that the self-evident importance of SES in education in fact lacks an evidential basis. Specifically, the association between SES and academic outcomes is often quite weak, the definition and operationalisation of SES is imprecise and hazy, the causal direction of effects between SES and outcomes are not clearly established, and finally the putative strong link between SES and outcome invites policy-makers to draw unrealistic inferences about what can be achieved by redistributive resource policies. These are discussed in turn.

1.3.1. Weak SES effects

Despite a widespread perception that SES must heavily influence educational outcomes, the association is far from overwhelming. The PISA researchers, while focusing heavily on issues of 'equity' and disadvantage in their key survey reports, note that for example, for performance in science, "12.9% of the variation in student performance … is associated with socio-economic status" (OECD, 2016; 216). They also note that many disadvantaged students are "resilient" and "succeed in attaining high levels of performance" (OECD, 2016; 217). In fact, disadvantaged children in the top-performing countries in PISA are performing in many cases as well as high SES children in more average-performing countries. In an influential meta-analysis, Sirin (2005; 438) argued that the association between individual student SES and academic achievement is of "medium" strength, but only when many variables are included in building the construct of SES, a point which will be revisited below. The analysis of Letourneau, Duffett-Leger, Levac, Watson, and Young (2013) suggested that the link between social class and educational achievement is "very small to small". Willms (2003: 10) reported SES as "significant" in its effects on academic outcomes, but "far from being deterministic" (p. 39). In one of the most widely-cited analyses of the SES-achievement link, White, 1982: 461) argued that "as SES is typically defined… and typically used …, SES is only weakly correlated with academic achievement."

1.3.2. Imprecise and inconsistent measurement of SES

The conceptualisation of SES varies across different studies, and even its precise meaning is often hazy and imprecise. As White noted, "although 'everybody knows' what is meant by SES, a wide variety of variables are used as indicators of SES" (1985: 462). It is commonly referred to as a 'complex multi-construct' variable, but the inconsistencies in the choice of the components used to create a valid indicator can sometimes appear to border on the à la carte. The core measures used are parental attainment in education and household income (or family wealth). Occupational status is also frequently added to this mix. Sirin (2005) argued that social class, parental occupation and parental education should all be accounted for, but also home resources, neighbourhood and school characteristics. The PISA survey has used three concepts: family wealth, parental education, but also, derived from Pierre Bourdieu's influential ideas around cultural capital, assessment of 'home resources' such as books in the home. The latter idea seems very problematic and perhaps dated – having books around the house might be an attempt at signalling a level of cultural sophistication to visitors, and thus a reflection of SES rather than a component of it. Or more practically, a family in an urban apartment might use their local library instead of buying books, or store thousands of books on an e-reader. Munsell, Kilmer, Vishnevsky, Cook, and Markley (2016) argue that SES is "one of the most elusive constructs in the psychological literature" but propose that two basic components need to be included – parental education and household income. They also argue for including "measures reflecting resource-related challenges of living" (p. 2832). It should be noted that in practice many analyses have had to operationalize SES more crudely as a dichotomous variable based on whether a student is entitled to free or reduced price school lunches, see Sirin (2005).

1.3.3. SES, causation and correlation

A statistical association between social class and educational attainment should not be inferred as indicative of the causal strength of the former in influencing the latter. Merely showing that children whose parents are better educated and wealthier do somewhat better in school than children whose parents are less well educated and less wealthy, does not establish that the former are doing better *because* their parents are wealthy and better educated. Cognitive ability is strongly correlated with educational success (Deary, Strand, Smith, & Fernandes, 2007; Roth et al., 2015); behavioural genetic research has also established that cognitive ability is highly heritable (Plomin & Deary, 2015; Plomin, Defries, Knopik, & Neiderhiser, 2016). Children may do well in school because they have higher cognitive ability, and this may be partly inherited from parents who did well in school, at least in part because they had higher levels of cognitive ability. Recent work based on large twin datasets, and on five longitudinal studies, using genomewide association scores, has established that educational outcomes for parents and their children are similar for both genetic and environmental reasons, see Belsky et al. (2018); Ayorech, Krapohl, Plomin, and von Stumm (2017).

Genes can influence non-cognitive, as well as cognitive abilities. Personality characteristics have been identified that are also partly heritable (Turkheimer, Pettersson, & Horn, 2014); some of these like conscientiousness, perseverance, and emotional stability may be useful in sustaining people's educational and employment careers (Heckman & Rubinstein, 2001), and partly inherited by their children.

1.3.4. SES – Drawing the wrong conclusions?

Overall, policy-makers seeking to reduce educational inequalities by focusing on economic disadvantage may have been seduced by an unrealistic picture of a powerfully influential SES. The construct is sometimes employed when it is bloated with difficult-to-defend appendages like number of books in the house, or à la carte mixtures of typically confounded or overlapping variables. SES itself may be partly an outcome of heritable individual characteristics that also shape educational success. The problem is that policy-makers may be invited to draw unrealistic inferences about what policy might achieve in terms of reduction in inequality in education because SES is implicitly presented as primarily an economic variable. Those constructing the composite measure of SES may directly or indirectly include social, cultural and personality attributes in their analyses; however if significant differences in educational performance appear to be "attributable to SES", then the policy conclusion that is often drawn is that economic intervention to ameliorate the effects of different levels of SES should easily reduce differences in educational outcomes. Hence the widespread and somewhat unquestioned use of policy measures noted in 1.2 above.

The purpose of the empirical analyses in this paper is to highlight the problematic nature of the concept of SES in academic performance by examining the relationship between the two background and academic performance in the PISA survey.

2. Methodology

Data were drawn from a publicly available dataset which included data on SES as well as academic performance: the PISA survey.

2.1. The Programme for international student assessment (PISA)

PISA is the largest systematic assessment of international

educational standards, examining the skills and knowledge of representative samples of fifteen year olds, at an age when students in most countries are approaching the end of compulsory schooling. The OECD first implemented the study in 2000 when 32 countries participated. A triennial survey, it will include 70 countries in its seventh cycle of 2018. The core countries originally participating were mainly the relatively wealthy members of the OECD, but now include many more ones, typically poorer. The initial major domains of assessment were reading and mathematics, but latterly included assessments of science and different types of problem solving. The most recently available data are based on the 2015 cycle, published in 2016. In that sweep, it assessed samples of students on reading, mathematics, science and collaborative problem-solving in over 65 countries, and several distinct regions within countries. In total, 519,334 students participated in 2015. The students taking part in PISA are drawn from a randomly selected and representative group of schools in each participating country or region.

3. Results: Analysis of the link between SES and academic test performance in PISA

PISA provides a complex set of ten 'plausible scores' in reading and ten 'plausible scores' in mathematics for all participants based on sampling theory.[1] A Principal Components Analysis of these twenty measures was run, and a single component could explain 84.4% of the variance in the 20 plausible values, eigenvalue = 16.9. This underlying component was saved for analysis as the dependent variable (and labelled 'Mathematics and Reading Ability', or MARA score).

Of the overall sample, 492,193 respondents had a component score for the MARA variable. This value was entered as a dependent variable in a multiple regression, while two continuous measures derived from the PISA dataset were entered as independent variables. These were derived household income,[2] and 'index of highest parental educational achievement'.[3] The adjusted R-squared indicated that 10.8% of variance in academic performance was explained by the two independent variables together, with the standardised betas respectively for household income at 0.23, and for parental education at 0.16. In terms of r, the partial correlation between MARA and parental education, controlling for income, was $r = 0.16$, ($p < .001$), while the partial correlation between MARA and income, controlling for parental education, was $r = 0.22$ ($p < .001$).

Using raw academic performance in Mathematics for example as the dependent variable, the modest relationship between household income and academic performance is clear. The PISA mathematics scores are constructed to have an overall standardised mean of 500 for OECD countries. The unstandardised beta for household income in the model for the mathematics score is 9.57. This means that an increase in household income by two standard deviations – taking, for example, a poor family from far below the average to far above it in income – would translate into less than a 20-point increase (2 * 9.57) in a mathematics score averaging 500; i.e. less than four percentage points. For reading score, a two standard deviations increase in household income was associated with an increase of just under 17 points on country outcomes of average 500, or < 3.5 percentage points.

However, these figures disguised quite distinct patterns in relation to their influence and the wealth of the country. Data on standardised GDP per.

capita are available on the UN website, unstats.un.org (2017). Considering the data for 2015 (the year of the PISA survey), it becomes clear that increased family wealth has some association with the academic performance of those from the poorest countries taking part in PISA, but very little, or even a negative relationship in the wealthier countries. The size of the standardised beta by country as a measure of the importance of household income was generated by running a series of 65 multiple regressions (one for each country) where the dependent variable was the MARA score while the independent variables were household income and parental educational attainment. A subsequent system-level (or country-level) analysis showed that a Spearman correlation between GDP per capita and the beta for 65 countries was −0.605. The countries where household wealth had the strongest association with a student's MARA score were Peru, Lebanon, Costa Rica, Colombia and Indonesia – among the poorest participating nations. Those where household income had the weakest association with performance were Iceland, Qatar and Norway – among the wealthiest. In Fig. 1, a diagrammatic relationship of the strength of the household income-MARA score beta (standardised to a mean of 0) is presented in the context of the standardised GDP by country for 2015. The relative importance for household income in poorer countries in its association with MARA scores is clearly visible, but this declines as one moves from left to right (towards the wealthy countries).

The pattern for the relationship of Parental Educational attainment is quite different. The overall relationship in the 65 country betas is positively associated with GDP (Spearman's rho = 0.420) whereby the MARA score of the participants is more closely associated with their parental educational achievement in wealthier countries compared to poorer ones. Parental Education attainment has only a tiny association with children's performance in MARA in countries like Algeria, Lebanon, Turkey, Colombia and the Dominican Republic, but had a far higher association in wealthier countries like Luxembourg, the Czech Republic and Japan. Fig. 2 presents the diagrammatic relationship of the strength of parental education beta (standardised to a mean of 0) with that of standardised country GDP.

In fact, the association of the two sets of betas (household income link to MARA, and parental education attainment link to MARA) across 65 countries is significantly negative (Spearman's rho = −0.420). The former tends to be more important for MARA scores in poor countries but fades close to irrelevance in wealthier ones, while for parental education, the opposite happens, although to a slightly weaker extent; it tends to be more important in wealthy countries and more trivial in poorer ones. It is also widely known that there tends to be a positive relationship between overall academic performance and a country's wealth expressed in GDP. Thus it is not surprising to find that the association or size of household income beta by country is negatively associated with the MARA score. Fig. 3 presents the relationship diagrammatically between the standardised MARA score and the size of the household income beta. One possible causal interpretation of this association might be that as countries grow wealthier, they can direct increasing resources into the national education system to allow children from poorer families to escape the impact of family poverty on their academic performance, thereby lifting the overall country academic performance.

In order to formally test for an interaction effect between GDP and the household income beta, and the family education beta, two variables were created – the product of GDP and income beta, and the product of GDP and family education beta. MARA by country was regressed on GDP per capita, household income beta, family education

[1] PISA presents its respondents with a subset of items from a larger total item pool. Because different groups of respondents answered different but overlapping sets of items, it is difficult to produce traditional outcome scores. Item Response Theory (IRT) scaling is used to generate multiple imputations based on an individual's set of responses. These ten multiple imputations are the 'plausible' scores in the domain. See PISA 2015 technical report (OECD, 2017).

[2] The PISA survey assesses household wealth, and this is based on a number of possessions within the family home, such as a room of one's own for the respondent, a link to the Internet, a car or cars, baths and showers, or tablet-style computers. From this, a derived measure, employing Item Response Theory, is used to generate a normally distributed continuous set of scores, acting as a proxy to a household income measure for each respondent.

[3] The PISA survey collects data on the educational attainment of both the mother and the father. The measure 'Index of highest educational level of parents' corresponds to the highest level of either parent.

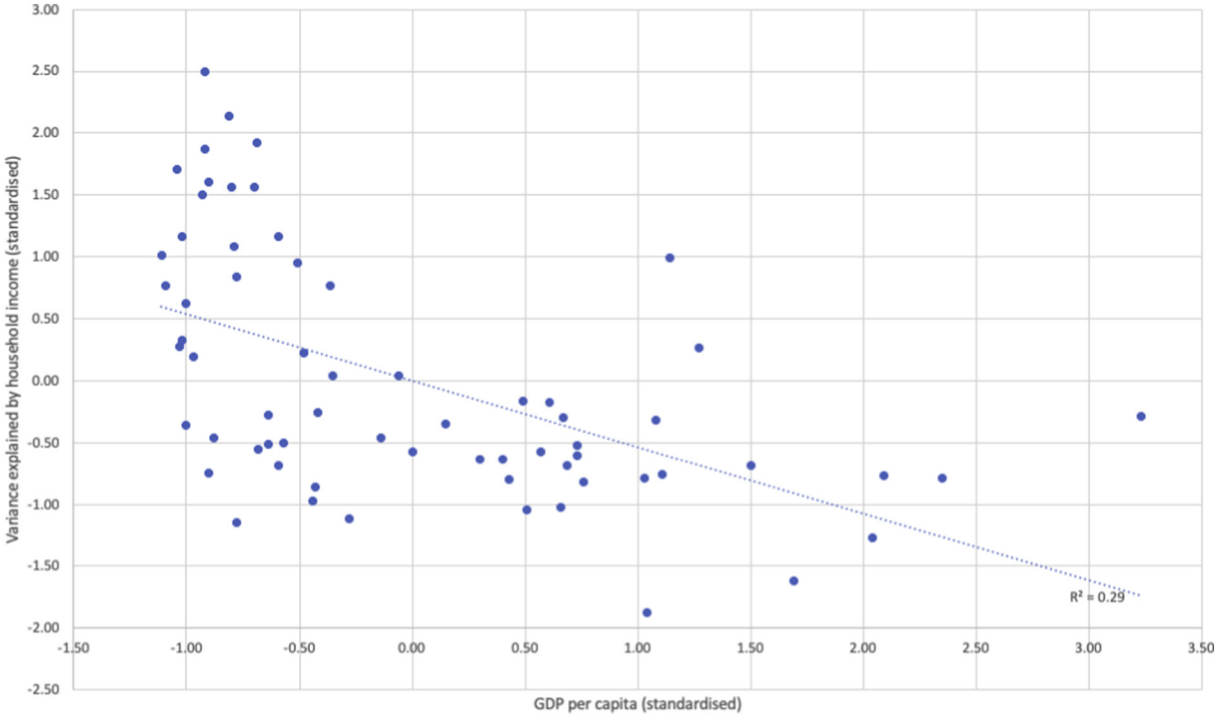

Fig. 1. Scatterplot indicating negative relationship between GDP per capita, and variance of MARA explained by household income in 65 countries. Country wealth increases from left to right.

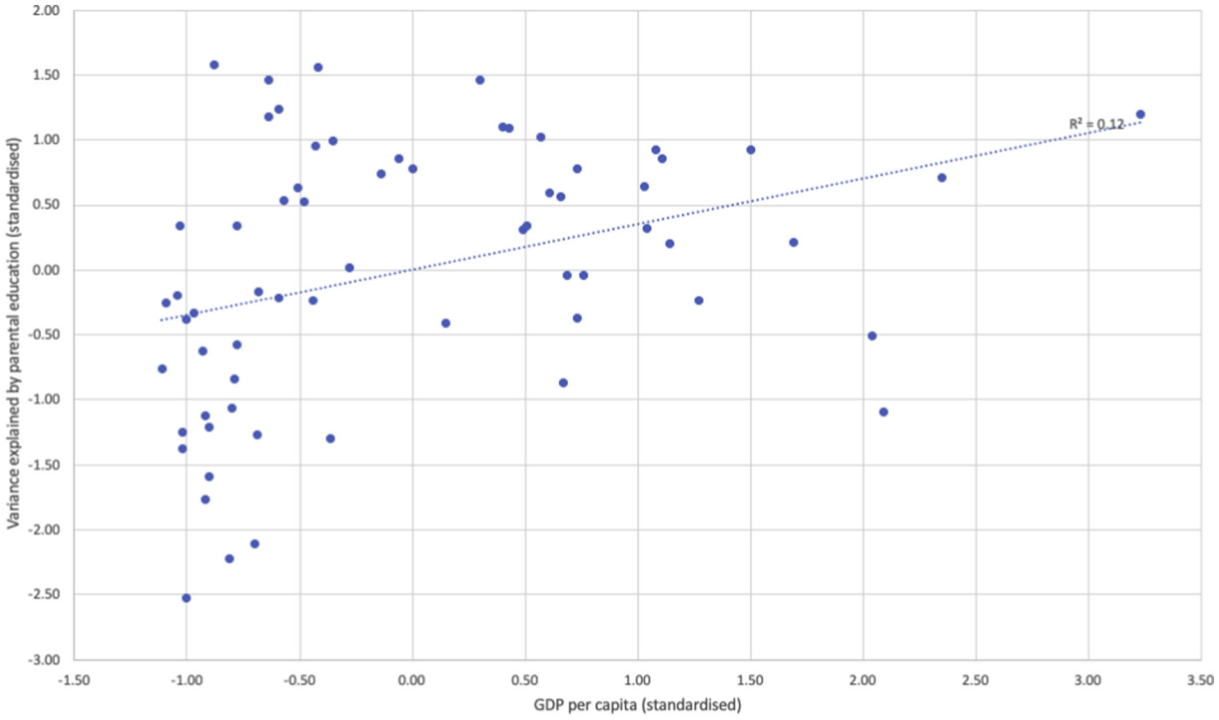

Fig. 2. Scatterplot indicating positive relationship between GDP per capita, and variance of MARA explained by parental education in 65 countries. Country wealth increases from left to right.

beta, GDP * Household income beta, and GDP * Family education beta. Table 1 below provides the standard coefficients for the independent measures, the t, and the statistical significance of each. It demonstrates that there was a significant interaction effect as the two product measures were statistically significant.

A comparison was also undertaken of academic performance between those whose parents were in the above-average 'household income' but below-average education attainment, versus those whose parents were in the above-average levels of education, but below-average in income. Of the entire sample, 16.2% (n = 83,920) had parents who were wealthier than their national average but below the median in terms of educational achievement for their country, while 21.9% (n = 113,542) were economically poorer than average but with above median-average educational attainment for their country. The

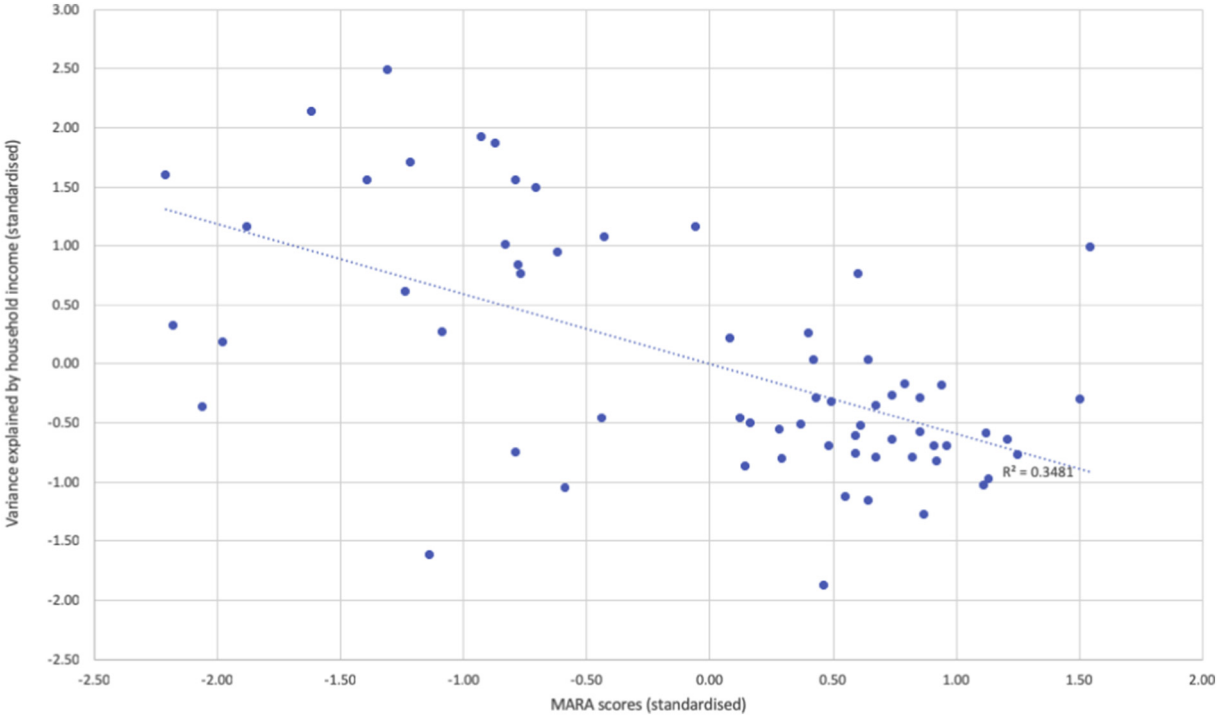

Fig. 3. The relationship between a country's performance in MARA scores in PISA 2015, and the variance explained by household income.

Table 1
Country MARA scores regressed on three independent measures and two interaction (product) measures.

Variable	Standardised Beta	t	P.
GDP per capita	1.170	3.926	< 0.001
Income beta	−0.438	−3.294	=0.002
Education beta	0.560	4.626	< 0.001
GDPpc * Income beta	0.363	3.624	=0.001
GDPpc * Education beta	−1.112	−3.562	=0.001

academic scores of the children of the latter group were statistically significantly higher than the former; 0.09 (s.d. = 1.05) to −0.05 (s.d. = 0.92), t value = 31.6, $p < .001$. This suggests it is better for a child's academic performance to have better-educated but poor parents, rather than less well-educated wealthy parents (though of course overall having parents both wealthy and educated is optimal). In a majority of the PISA countries (48 out of 65), the academic performance of those with poorer but better educated parents, was higher than those with richer parents who had below median average educational attainments. The minority of countries where this pattern was reversed had lower GDP per capita, e.g. the five countries where family wealth was most important relative to parental education attainment in relation to their children's MARA value were Lebanon, Peru, Turkey, the Dominican Republic, and Trinidad & Tobago. In Fig. 4, the relationship between the standardised GDP per capita by country, and the standardised gap by country between the MARA score of those with wealthier, less educated parents, versus those with poorer but better educated parents is presented digrammatically. The correlation between these standardised scores at a system level by country was $r = -0.473$, i.e. household income is relatively more important than parental education in the poorer countries in its association with the MARA score. This pattern is reversed for wealthier countries where parental education becomes more important.

4. Discussion

The purpose of the paper was to identify a number of problems with the manner in which the variable of SES is used and understood in educational contexts. Through the analysis of two consistently used ingredients of SES – household income, and parental education – the concerns outlined in the introduction were demonstrated in a statistical way. First, it was established that the association between a standard conceptualisation of SES and standardised test performance in a high-quality survey, was very modest. Despite pervasive beliefs that SES virtually defines academic performance, the empirical reality is that the relationship tended to be statistically weak. Even the two consistent measures usually considered core to the understanding of SES, household income and parental education, are themselves inter-correlating variables; these are influenced by alternative individual characteristics, such as cognitive ability, that are as likely to be causal in terms of educational attainment as is SES.

It should be made clear that this paper is not an argument against the use of latent variables; they are of great value in conducting analyses in the human sciences, where data measurement in many areas is very prone to large amounts of error. The dependent measure mainly used in this paper, 'MARA' is itself a latent variable combining multiple measurements of mathematics and reading assessment. But the paper does specifically critique the widespread and often ad hoc use of a latent variable of 'SES' on a number of grounds:

The measurements used to create the latent variable MARA are highly correlated, and are based on similar units of measurement. The variables used to create a measure of SES on the other hand are far less correlated, and the units vary across continuous, ordinal and categorical variables;

Different elements of SES are playing distinct non-linear roles depending, it would appear, largely on the country's state of economic development. Thus, family wealth in the SES measure was of reasonable importance in poor countries, but close to irrelevant in wealthier ones, while parental education became far more important in the very wealthy ones. Therefore, yoking different non-linear elements together disguises patterns rather than revealing them;

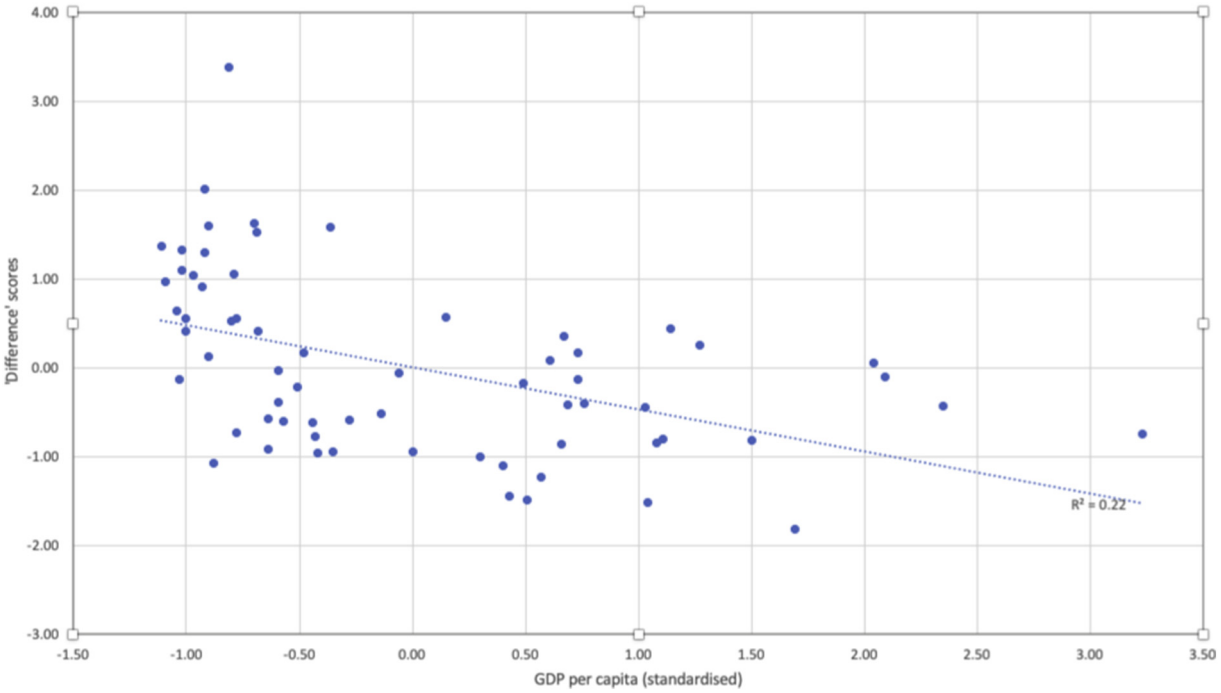

Fig. 4. Scatterplot displaying the relationship between a country's wealth (in GDP per capita), and 'Difference' in MARA scores between *well-educated + poor* parents versus *poorly-educated + wealthy* parents.

Parental education is particularly problematic as a measure of social class since while it is associated with subsequent family wealth, the work of behavioural geneticists has also confirmed that parental education is linked to parental cognitive ability and thus to their children's cognitive ability and also educational performance. Adding it into the mix as part of a latent variable of SES, popularly thought of as a variable revealing the strength of external economic forces in an individual's life, is inherently misleading;

Following on from this, while SES is often calculated as a latent variable based on economic, educational, genetic, cultural values, it nonetheless tends to be interpreted as a simple economic measure; social policy makers become over-confident that links between SES and life outcomes can be modified for the better by tweaking economic policy.

If the MARA scores are read at least as at least partially representative of a parental-offspring resemblance, then the pattern might be interpreted as consistent with the Scarr-Rowe hypothesis. This proposed that under conditions of hardship, genetic influence is suppressed; a more enriched environment enables children to reach their full genetic potential (see Turkheimer, Harden, D'Onofrio, & Gottesman, 2009). The GDP per capita thus provides an index of average privation, or its absence; in poorer countries this means that household wealth has a greater impact on the outcome. But as the society becomes wealthier the importance of household wealth diminishes, and parental education – as a proxy for their cognitive ability – takes on more importance. The data are also consistent with the 'meritocracy hypothesis', associated with Herrnstein & Murray, 1994, which suggests that as societies become more economically advanced, there is a tendency for social stratification to be made increasingly on the basis of cognitive ability.

However, the analysis, apart from the identifying the weakness of SES as a unitary concept in predictive power, as noted above, also pointed to a further difficulty in basing SES on both parental education and household income – the combination of both concealed rather than clarified relationships. Specifically, when the wealth of the country was considered in the PISA data, it became clear that while one element – household income – was relatively important in its association with mathematics and reading ability for poorer countries, that association became trivial, or even negatively associated with the performance in wealthier countries. By contrast, in richer countries, parental educational attainment was relatively predictive of the child's mathematics and reading performance, but this relationship largely disappeared in poorer countries. Combining parental education and household income thus obscures what policy-makers could take away from the data – raising educational standards in poorer countries could benefit from redistributive policies to help poorer families, but these have reached the limits of their potential in the wealthy countries. It was demonstrated that even impossible levels of redistribution (for example moving all families at two standard deviations below average household income, to two standard deviations above) would barely affect the results because household income is so weakly associated with performance in richer countries.

As a limitation, it should be noted though that the analysis here used standard regression and correlation methods on cross-sectional data. This assumes that the impact of independent variables such as parental education and household income on the dependent measure was linear. One needs to be cautious about this assumption. Cooper and Stewart (2013) assessed 34 high-quality studies examining the causal impact of low income on outcomes in children's lives. There was evidence that income changes do significantly affect very young children's cognitive development, particularly if the changes were long-term, and the children's families were from the bottom-quintile of the income distribution. The 34 high-quality studies were also disproportionately carried out in the US where relatively high levels of income inequality for an advanced economy may in effect make the families in the poorest 20% of the population more economically similar to families in poorer countries. Also, it should be noted that the analysis pointed to stronger effects of household income among the poorer participating countries in PISA. But PISA's participating countries are mainly wealthy (OECD members) or middle-income. The mean GDP per capita of the participating countries was 27,267 dollars. This compares to a world mean of 17,300 dollars GDP per capita. The poorest participating country in PISA 2015 was Moldova with a GDP per capita of 1602 dollars. But the 45 poorest countries in the world – mainly in sub-Saharan Africa, and

southern and western Asia, are poorer than this (see United Nations, 2017), and did not participate in PISA (UN Statistics Division). And many middle-income countries were also absent. A reasonable interpretation might be reached that family and wealth could well play a stronger role in determining cognitive outcomes of children if the poorer half of the world were included in a similar analysis.

Concluding recommendation: In terms of conceptual clarity, researchers could benefit with moving away from an amorphous, ill-defined and inchoate concept like SES, and instead using clearly-defined, quantifiable, and stand-alone measures like parental educational attainment and household income. Their distinct patterns of influence can then be better understood, as can the potential and limits of using social policy levers like allocating increased resources to disadvantaged students.

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