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ORIGINAL ARTICLE

Poverty, inequality and mathematics performance: the case of South Africa's post-apartheid context

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Abstract South Africa's recent history of apartheid, its resultant high levels of poverty and extreme social and economic distance between rich and poor continue to play-out in education in complex ways. The country provides a somewhat different context for exploring the relationship between SES and education than other countries. The apartheid era only ended in 1994, after which education became the vehicle for transforming society and a political rhetoric of equity and quality education *for all* was prioritized. Thus education focused on redressing inequalities; and major curriculum change, with on-going revisions, was attempted. In this sense engagement with SES and education became *foregrounded* in policy, political discourse and research literature. Yet for all the political will and rhetoric little has been achieved and indicators are that inequality has worsened in mathematics education, where it is particularly pronounced. This paper proposes that continued research confirming poverty–underachievement links, which suggest an inevitability of positive correlations, is unhelpful. Instead we should explore issues of disempowerment and agency, constraints and possibilities, and the complex interplay of factors that create these widely established national statistics while simultaneously defying them in particular local contexts. Such research could shift the focus from a discourse of deficit and helplessness towards a discourse of possibilities in the struggle for equity and quality education for all.

Keywords Performance · SES · Redress · Inequality

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1 Introduction

South Africa (SA) provides an 'extreme' case of performance gaps between high and low SES learners even while political will and resource allocation for redressing inequality are identified as a national priority. SA differs from other contexts in several respects, including our extreme levels of inequity and our recent apartheid history that systematically disempowered the majority of South Africans. Our extreme levels of social and economic distance between rich and poor continue to manifest in education in complex ways. Findings of the extent of the relationship between socio-economic status (SES) and mathematics performance/learning are found in large-scale studies that assess the state of education across SA (including comparatively to neighbouring and other countries), published mostly in books or reports. Academic journals tend to publish smaller scale classroom-based case study research that explores this relationship from a qualitative perspective. Additionally, press articles and speeches by politicians, academics and union leaders provide a window into public engagement with these issues.

SA's heritage of inequality under apartheid provides a specific context for exploring the relationship between SES and education. Following our first democratic elections in 1994, education became the vehicle for transforming society. A political rhetoric of equity and quality education for all was prioritized. Almost all educational deliberations foreground redressing inequalities of the past, and major curriculum revisions have been attempted to this end. Thus engagement with SES and mathematics education gained particular prominence post-1994 although this was also a focus of the resistance movement in the 1980s. In a vicious cycle, however, despite high levels of resource allocation and strong political will, extreme levels of inequality and

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poverty continue to be at the heart of the failure of educational innovation aimed at reducing inequality. A key question that we are beginning to ask is whether it is possible to systemically address educational inequality in this context of extreme socio-economic inequality. This question sits uncomfortably, however, as it can strip us as mathematics educators and researchers of our agency to contribute to improving mathematics learning for low SES learners. Additionally, several localized mathematics education projects point towards positive impact in terms of redressing the performance gap with low SES learners (e.g. Penreach 2011) and there is thus evidence, at least at local levels, of successful models of intervention. A difficult challenge for such projects is whether such redress is possible on a national scale (Pausigere and Graven 2014).

I begin the paper with a brief overview of SA's levels of poverty and inequality and the education context as these are critical to understanding the particular problematics illuminated by the South African context.

2 A heritage of educational inequality

Over 60 % of South African children live in poverty (Fleisch 2008) and SA has long been one of the most unequal countries in the world. Almost 20 years after the first democratic election, poverty levels are somewhat lower compared with the apartheid era, but inequality has worsened (National Planning Commission [NPC] 2011). The system of apartheid was predicated on ensuring that these inequalities were structured along racial lines. Under apartheid, building on decades of segregation and colonial rule, four racially classified population groups were legislatively maintained, namely: White (held to be those of European origin), Coloured (indicating 'mixed race' or those who did not fit other racial categories), Asian (of Asian origin) and African (of African origin). From 1948 all South Africans not designated 'White' were denied democratic participation and state resources were allocated differentially for services such as education and health. Over time the formal imposition of apartheid from 1948 accelerated the wealth gap between population groups.

Inequality extended into education in deep ways. Prior to democracy, 17 Education Departments existed, each with their own budget. The continued dominance of English as the language of power, commerce, government and education reinforced these inequalities. Democracy did not change the reality that the majority of learners learn in a language that is not their primary language. Thus race, language and class are interwoven in complex ways, as is their relationship to educational opportunity. On 22 July 2011, in the opening address at the Education International Sixth World Congress, South African Deputy President Motlanthe confirmed that education and unequal access to education remains a national priority:

> Achieving Quality Education speaks to the single most important test facing our education system. Since the advent of democracy in 1994 we have successfully integrated the many racially and ethnically-based education departments into one unitary national system… But the quality of education leaves much room for improvement. With this in mind our government has declared education a national priority.

Yet for all the political will and prioritization, little has been achieved in terms of redress. In his speech to the South African Democratic Teachers Union (SADTU) on 28 September 2011, Vavi (Congress of South African Trade Union's [COSATU] General Secretary) articulated the equity crisis in education:

> Our education system is in crisis. In fact calling it a crisis is an understatement. This is a catastrophe. Every day children of the working class and the poor are being condemned into a deep black hole with minimal chances of escape… Apartheid fault lines remain stubbornly in place in our education system. Children born to poor parents remain trapped in an inferior education with wholly inadequate infrastructure… the National Planning Commission says 88 % of African schools are regarded as dysfunctional.

This speech captures an emerging public sentiment that the government is unable to redress rampant inequality in education. Since 1994 the complete overhaul of the education system has been identified as a key priority for building a new democratic South Africa. Curriculum 2005 (C2005) was introduced in 1997 and was premised on a learner-centred, outcomes-based approach to education with an explicit political agenda which was captured in the introduction to the C2005 policy document:

> In the past the curriculum has perpetuated race, class, gender and ethnic divisions and has emphasized separateness, rather than common citizenship and nationhood. It is therefore imperative that the curriculum be restructured to reflect the values and principles of our new democratic society. (NDE 1997, p. 1)

The point about C2005 being a change from the curriculum under apartheid is important, because the *need* for redress was taken for granted. Thus, while in many countries curriculum change is met with resistance, the C2005 Review Committee report showed overwhelming support for it despite indicating low levels of understanding

(Chisholm et al. 2000). The support, even in the absence of understanding, was due to its resonance with the aims of the building of a new democratic SA. However, C2005, and subsequent revisions, failed to realize these aims.

The assumption that inequity in education can be addressed through curriculum change is problematic, and some might argue that rapid and repeated curriculum change is partly responsible for the worsening crisis. The jargonized rhetoric of the policies and the unrealistic demands on under-resourced schools with little sustained teacher support further worsened the educational gaps between the rich and the poor. Reddy's (2006) report on TIMSS foregrounds curriculum issues as contextual factors relevant to SA's poor performance. Similarly Chisholm and Chilisa (2012) point to rapid and dramatic curriculum change as a key factor explaining why SA learners perform worse than their Botswana counterparts living just across the border in similar circumstances with a similar curriculum.

Along with our recently implemented curriculum, in the form of the Curriculum and Assessment Policy Statements (CAPS) (DBE 2011), Annual National Assessments (ANAs) in Grades 1–6 and 9 have been introduced. The ANAs are explicitly focused on providing system-wide information on learner performance aimed at allowing for comparisons between schools, districts and provinces (DBE 2012). While their introduction indicates increased monitoring of the 'crisis' in education it does little to support the improvement of learners' performance. As in TIMSS, the results of these assessments show alarmingly poor mathematics skills across learners in the primary grades with average performance steadily declining each year from 68 % in Grade 1 to 27 % in Grade 6 (DBE 2012). The results for languages decline less over the years, to 43 % in Grade 6, indicating a seemingly greater crisis in mathematics which expands as the years progress. Unsurprisingly, these results concur with the poor results reported across earlier studies (e.g. TIMSS and SACMEQ studies) that similarly confirm that the crisis is exacerbated in mathematics. It is thus unclear as to what new information such costly assessments yield.

Two research projects in Gauteng and the Eastern Cape reported that teachers in their projects stated that the ANAs take on average 3.97 weeks of teaching/learning time (Graven and Venkatakrishnan 2013). Much of this time is spent on departmentally issued ANA exemplars. While the ANAs are intended to affect learning and assessment in positive ways and provincial remedial plans are intended to follow assessments, it is yet unclear how these will occur. A question to ask is whether resultant interventions will focus on improving learning or simply on improving ANA results through supporting teachers to 'teach to the test'. In the latter case an improvement in results might have more to do with increasing test familiarity and less to do with improved mathematics learning. Taylor's (2009) analysis of the standards-based accountability interventions between 2000 and 2003 revealed a focus on testing at the expense of capacity building and that improvements in performance mostly came from manipulating results by various measures. Thus, as with the assumption that curriculum change might be the route to solving the equity crisis, the assumption that national assessment of learners will address the inequity crisis is problematic.

Teachers are often reported to be at the heart of the crisis (Shalem and Hoadley 2009; Graven 2012). Teacher morale is at an all-time low with a large percentage of teachers indicating that they would leave the profession if they could (OECD 2008). Teacher attrition is greater in mathematics and science as these skills are highly sought after. Furthermore, it is becoming increasingly difficult to attract students into teaching as it holds low status as a profession. While teachers are often 'blamed' for the crisis, little systemic support is provided for teachers. Short one- or two-day courses by district officials do little to empower teachers to enact and make sense of the new mathematical and pedagogical practices promoted in curriculum revisions. Shalem and Hoadley (2009, p. 119) argue that the "relations between enduring economic inequalities in South Africa, an underspecified new curriculum and the bureaucratization of teachers' work have created an intractable pattern of accumulation of educational disparity among teachers in South Africa. Teacher morale needs to be considered in the context of these structural conditions."

With this contextual background I turn to review the literature relating SES and mathematical performance or learning opportunities. I engage first with large-scale studies identifying key factors and then with research seeking understanding of the complex relationships and mechanisms of influence of the factors. Through this review various questions about the nature of the relationship between mathematics and SES emerge, as particularly illuminated by the extremes of poor performance and inequality in the SA context.

3 Factors influencing performance

As with international literature, various factors have been identified through large-scale national studies as generating differentiation of educational performance. Valero et al. (2012) note that across countries different factors are foregrounded and explored. So, for example, in the USA race is a key factor of differentiation; in the UK, Europe and Australia socio-economic status is foregrounded; in some European countries it is ethnicity and home language; and in China and many African and Latin American

countries rurality is a key differentiator. South African research has tended to identify all of these factors but also health issues, such as HIV, which affect both educators and learners. Our apartheid history means that race and poverty are complexly intertwined.

In SA, since poverty affects more than half of our learners, education studies tend to focus on the poorest (but largest) SES group. As with international research (see Valero et al. 2012) much mathematics education data linking SES and performance is found within broader education research driven by national societal and economic concerns. In SA these include large-scale national research such as: the Department of Education's systemic evaluations in 2001 and 2007 (DBE 2008); SA's data gathered within TIMMS; the OECD (2008) *Reviews of National Policies for Education: South Africa*; the Development Bank of South Africa's (DBSA) (2009) *Education Roadmap: Focus on the schooling system*; and more recently the NPC's (2011) *Diagnostic Overview*. All these cite educational inequality as a critical issue.

These reports (as with international research) indicate correlations between school performance and socio-economic context. The reports highlight a range of factors affecting learner performance including: socio-economic status and social disadvantage; teacher knowledge, teaching time and teacher absenteeism; linguistic factors; poorly managed schools; and poverty effects including malnutrition and HIV/AIDS. Reports paint a consistent picture with little surprise or disagreement. To cite only a selection of poverty statistics, the OECD (2008) report outlines that in 2003: 24 % of children were often or sometimes went hungry; HIV-prevalence amongst children is around 5.6 %; 12.7 % of educators are HIV-positive; 3 % of children had no parents; 6 % of children live an hour or more away from a school.

These statistics play out in various ways across education but the OECD reports also point to mathematics results being consistently below other countries, including African neighbours with much less wealth, indicating that our poor performance cannot only be attributed to our levels of poverty. Furthermore, SA has the highest levels of between-school performance inequality in mathematics among the ten Southern and East African Consortium for Monitoring Educational Quality (SACMEQ) countries (Taylor 2009) that include Kenya, Lesotho, Malawi, Namibia, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

The 2003 TIMSS study, in which SA was the lowest performing of 50 countries, points to some important findings reported by Reddy (2006). Notably, SA had the largest variation in scores and the highest percentage of learners achieving below the Low International Benchmark. Average scores of SA learners in African schools were almost half of that of historically White schools (whose average was close to the international average) and mathematics scores for African schools decreased significantly from TIMSS 1999 to TIMSS 2003. This was not the case for other SA schools. The latter points to increasing inequality of mathematics performance between the wealthier and poorer schools. Interestingly, "comparisons across countries indicated that even when resources (e.g. high parental education and number of books) are in place, the South African average TIMSS mathematics and science scores were lower than other countries" (Reddy 2006, p. xiv). This begs investigation into the complex way in which our recent apartheid history continues to play out in education.

Another important cluster of research relating to SES and education performance is reviews that synthesize the findings of large-scale studies and other relevant research. These reviews do not gather their own empirical data and are largely conducted by individuals and partnerships between individuals in various organizations. The reviews tend to collectively point to an absence of robust engagement with possible mechanisms connecting various factors with under-performance and the complex interrelationship between factors. I elaborate on these below.

4 Seeking explanations for complex relationships

The Report of the President's Education Initiative Research Project by Taylor and Vinjevold (1999) drew on a wide range of research to provide a basis for future planning of educator development. Here Taylor (1999) outlines a model of the curriculum implementation process, drawing on notions of the intended, implemented and attained curriculum. Within the attained curriculum he elaborates on student characteristics that influence what is attained, namely: background, household economic and cultural capital, attitudes, aptitudes and expressions in the model. Bernstein's notion of knowledge codes, and differences in knowledge codes available to learners of varying social classes, is used as a guiding framework for understanding differences in learning. Following on from this work, Taylor et al. (2003) conducted a large-scale sustained reflection and meta-knowledge analysis of generalizable knowledge of SA schooling in research published between 1998 and 2002. A contribution of this work is a model of various factors that influence learning in SA schools and a Bernstinian analysis of how to account for the relationship between factors and achievement. They note that there are several factors indicating a weak positive correlation with mathematical performance, namely: home language, gender, learner interest, time allocated to the subject, physical

resources, teacher qualifications, home language of the teacher and absence of the teacher.

The analysis, however, does not provide insight to ways forward to addressing differential access to knowledge codes across our SA classrooms. A question in this respect is how might teacher education address this issue and to what extent might differential access to knowledge codes be playing out in teachers' own mathematical knowledge. Furthermore, such models fail to account for mechanisms enabling pockets of success stories across low SES communities.

Fleisch's (2008) book, *Primary Education in Crisis: Why South African schoolchildren underachieve in reading and mathematics* similarly synthesizes research on factors contributing to the crisis but focuses on reading and mathematics. He further explores influencing factors in the socialization and enculturation of learners at home—parental education, books in the home, language in the home, opportunity for ECD care, families without parents as well as the effects of child labour (also of concern in some Asian and conflict-affected countries). However, Fleisch cautions that we should not only approach the problem of low SES and education achievement from a point of social and cultural capital but rather we must build 'a robust understanding' of the relationship and look towards the structural barriers such as no money for transport to school, poor nutrition from early childhood and so forth. He further notes: "Poor families rather than being just a source of social and cultural deficit, are important supporters of educational success…poor South Africans share with the middle class an unqualified faith in the power of education. For poor families education is the way out of poverty, and as such many spend a large portion of their disposable income on school fees, uniforms and transport to get and keep their children in school" (p. 77).

Family support for education is a key resource within low SES communities that needs to be explored in relation to its influence on mathematical performance and how it might be further harnessed to support learners. It also points to a need for researching learners who have managed to defy strong statistical correlations between poverty and poor performance and to explore the range of resources within their schools, families and communities that they have drawn on for their success. Such studies might begin to shift the dominating deficit discourse of learners living in poverty. Of course, poverty by its definition involves deficit in terms of not having basic 'goods'; however, the deficit discourse extends problematically within mathematics education to what is considered possible for low SES learners. It also extends problematically to assumptions about learner abilities and to low expectations resulting in self-fulfilling prophecies as learners are not provided with opportunities to learn at higher levels.

A key problem with deficit discourse in relation to SES and performance is that it tends to imply *inevitability* of poor performance and not only strips individual learners of their agency but communicates to educators to hold low expectations of such learners. As Carnoy et al. (2011, p. 8) write, within low SES schools teachers "accepted low performance levels of students and their own low levels of knowledge and low expectations as the norm—business as usual." We need to ask how we might work to increase teacher expectations of low SES learners, especially given the current context of ANAs beginning from the first year of primary school. This context is likely to entrench assumptions of low 'abilities' given the extremely poor results across the poorest provinces and schools. We should thus also investigate the possible unintended consequences of national assessments.

Fleisch (2008) unpacks SA's 'two nations' and bimodal distribution of achievement. Just as SA has two economies, it has two education systems serving those economies (TIMSS results discussed earlier confirm this). He outlines a range of health issues relating to underachievement, including malnutrition, parasite infections, hearing loss, asthma, foetal alcohol syndrome and HIV/AIDS. Each of these health issues impacts differentially on SES groups across provinces in complex ways, with low SES groups being most affected. He argues that while studies consistently find strong positive correlations between socio-economic background, poverty and underachievement, "the existing approaches to establishing the magnitude and nature of the relationship have been generally disappointing" (p. 53). He emphasizes that poverty must be understood in its full complexity and not simply in economic terms and argues for "the need to understand the underlying structural dimensions of persistent poverty, which engages the complexities of social relations, agency and culture, and subjectivity" (p. 58). He thus argues that even while the quantum of poverty in SA is experienced in other countries, the *dependency* of the poor and their profound disempowerment is perhaps greater than for the "poverty stricken peasantry of our neighbours of the north" (p. 59). Thus he concludes that "while the links between poverty, dependency and performance are theoretical, with few theories that provide a coherent account of the mechanisms that connect them, it is an important insight into the particular context or the contextual specificity of South Africa" (pp. 59–60).

The notion of dependence and compliance as a specific aspect of poverty entrenched under apartheid requires further research. Adler argued in her presentation to the FRF Chair Community of Practice forum in November 2010 that we have to 'interrupt' the learning and teaching culture in schools, where learners are passive, learning is teacher-dependent and the focus of teaching is on

compliance (compliance to national assessments and producing required documentation). This resonates strongly with my own recent research on student learning dispositions of primarily low SES learners in the Eastern Cape (one of the poorest of SA's nine provinces in the southern part of the country). This indicates that learners tend to equate mathematical success with teacher dependence, compliance and careful listening rather than relating it to independent thinking, problem solving or making sense of mathematics (see Graven et al. 2013). More research is needed to examine ways in which *dependent* poverty and dependent passive learning dispositions might impact on mathematical learning. Prominent leaders, such as Mamphele Ramphele, are increasingly noting the need to address South African 'mindsets' in order to 'reclaim' agency. In her speech 'Rekindling the South African dream', Ramphele (2013) argues:

> We have seriously under-estimated what it would take to walk the journey from being subjects of undemocratic governments, denied the right to make our own choices, to become citizens of a constitutional democracy, reclaiming control of our lives. We did not stop and take time at the beginning of the journey in 1994 to work on shifting our mindsets from those of compliant subjects to those of dignified citizens.

Reform notions of mathematical competence require active participation and sense-making. In this respect, passive compliant learning dispositions are likely to be a stumbling block to developing conceptual understanding that requires some level of learner agency to develop. Thus, given the discussion above, we need to begin to investigate ways to interrupt these dispositions both within society and within our mathematics classrooms.

5 Continental and cross-regional studies illuminating South African specificities

The African Monitoring Learning Achievement (MLA) project that began in 1992 was one of the first cross-national studies that SA participated in. Fleisch (2008), drawing on Chinapah et al. (2000), provides a table showing the numeracy and literacy scores of participating countries. The table shows that of 12 countries SA performed lowest in numeracy (30.2 %) as compared with the highest performing country Tunisia (60.4 %). Thus the SA score was half that of the top performing country. SA's performance in literacy was somewhat better (48.1 %), being fifth from the bottom, indicating SA's poorer relative performance in numeracy than literacy. Chinapah (2003) argues from the MLA data that there is a need for a holistic approach to educational quality. The policy recommendations for SA included focusing on in-service teacher development, the role of school heads and reducing pupil–teacher ratios. These were not noted for the majority of the other participating countries, although for other countries curriculum revision was suggested.

Carnoy et al. (2012) note that while we can learn from top-performing countries in studies such as TIMMS, the economic, social and educational conditions of those countries are very different from developing countries. It is thus more useful for African countries to compare with countries with similar resources and to research why these countries are doing better. The advantage of studies such as SACMEQ and MLA is that they seek to understand the nature of the relationship through comparisons with developing countries with similar economic and educational challenges.

The most recent 2007 SACMEQ study interrogates the relationship between the *SES of schools* and learner mathematics performance rather than only focusing on the SES of learners and performance. The study shows that *school SES* is a key factor in learner performance and is even *more significant* than teacher subject knowledge. In the report they emphasize that language, race and socio-economic status are highly related and caution that one should not attribute the entire difference between wealthier students and poorer students to SES, since some of this difference may be due to linguistic advantage (Spaull 2011). Spaull (2011, p. 1) notes:

> The research confirms previous findings that socio-economic status, and particularly school socio-economic status, is important when understanding student success or failure. Other factors which contribute significantly to student performance are homework frequency, preschool education, and the availability of reading textbooks. In contrast, teacher subject knowledge was found to have only a modest impact on Grade 6 student performance.

The issue about teacher subject knowledge perhaps not being as significant a factor as one might expect, noted above, requires further investigation since much teacher development work is focused on developing and researching mathematics knowledge for teaching. Particularly the work of Adler and colleagues (e.g. Adler and Davis 2006; Adler 2010) has focused on this aspect as a critical aspect of understanding and addressing the crisis in mathematics education (discussed further below).

Spaull (2011) continues that "maths distributions show that students from the uppermost quintile of SES far outperform students from the lower four quintiles. When decomposed by quintile, the distribution is bi-modal by top quintile and bottom-four quintiles, suggesting that there

may be two data-generating processes at work. It would seem that student performance does not improve evenly across the various SES quintiles" (p. 7). He notes that the data indicates that the effect of SES on performance is non-linear and SES is only significantly positively related to student performance at higher levels of SES. "Put differently, wealth has a greater effect on student performance at higher levels of wealth" (p. 16). The point about uneven influence of SES clearly gives weight to arguments that a range of complex factors come to bear on the way in which SES and academic achievement interact. As yet no explanations have been suggested for the unevenness of student performance within an SES quintile and thus begs further investigation.

Important in the SACMEQ study is that both individual and school SES measures indicate similar trends in correlation with performance. However, the study shows an interesting finding in relation to the *dominance* of the influence of a school's SES. Thus the study showed that: "a school's overall socio-economic status has a greater impact on learner performance than does a child's individual status. This means that placing a poor child in a wealthy school is likely to more than compensate for any negative effects of a poor home background" (p. 16). Again this finding suggests the need for further research. Reports which focus on low SES schools that offer quality learning experiences in mathematics begin to offer insights into this. For example, Christie et al.'s (2007) report on schools that work points to the importance of 'organizational cultures and mindsets that supported a work ethic, expected achievement, and acknowledged success' (p. 5) despite battling poverty. Such studies play an important role in generating discourse that focuses on success and excellence in mathematics achievement with low SES learners and schools—a discourse absent in national testing contexts that highlight poor performance in low SES contexts.

The Carnoy et al. (2012) study similarly compared across countries but focused on one region—the area in the north west of SA bordering with the southern part of Botswana. This allowed an innovative approach to cross-country comparisons as it took advantage of the strong similarities of the student populations on either side of the border. While the Botswana learners across the border do not perform particularly well in mathematics, their performance is significantly better than that of the SA students. Both populations of learners were mostly from poor backgrounds with similar linguistic backgrounds and similar health concerns such as levels of HIV prevalence. The curriculum is similar in both countries, although with differential histories of implementation and teacher support—gradual incremental change in the case of Botswana and rapid disruptive change in the case of SA (Chisholm and Chilisa 2012).

Carnoy et al. (2012) pointed to teacher quality and opportunity to learn (e.g. average of 52 lessons in SA and 78 in Botswana over a ten-month period) as key influencing factors on the differential performance across the border. While their study did not particularly pose questions addressing learner and teacher agency and dispositions, they note a "'South African effect'—that is, the years of apartheid may still weigh on teachers' and students' perceptions of how successful both can be academically" (p. 3). Their data suggests under-expectation of learners to be a key problem in South Africa. Chisholm and Chilisa (2012) from this study explore the way in which differential political histories shaped education and the role of teachers in the reform process:

> In Botswana, reform processes started with teachers and the introduction of new qualifications to upgrade their knowledge. In South Africa they began with changing curriculum documents and prescripts with which teachers had to work (p. 381). Additionally, SA's history of 'Bantu education' in the 1950s and the Bantustan system of the 1960s and 1970s was accompanied by physical and symbolic violence: the violence of repression of opposition and the violence of the subordination of aspiration and possibilities through the limited (and limiting) education made available (p. 385).

This research points to the effects of this repression on the dispositions and mindsets of SA learners and teachers as a possible particular SA problem that needs to be further interrogated in relation to its impact on under-performance and ways to counter it.

The Carnoy et al. (2011) study focused on the North West Province gathered information on student *and* teacher knowledge, indicating low levels of mathematics teacher knowledge in all but the highest SES schools. However, they emphasize that one should not argue simplistically that higher levels of mathematical content knowledge (CK) and pedagogical content knowledge (PCK) for teachers are a causal factor in higher performance of students. They note that it could also mean that "higher scoring teachers did not 'produce' these higher test scores but rather were 'matched' in some way with higher scoring students." (p.95). In the summary they write: "better teachers tend to be attracted to schools with better performing learners" (p. 7).

An important aspect of this study is that it measured gains in student learning through pre- and post-tests over an academic year rather than simply looking at SES and performance at a particular point in time. This design contributes a richer understanding of the relationship between SES and mathematics achievement as it places at its centre the Opportunity to Learn (OTL) and how this

might influence learning gains over time. The study found that factors such as the failure to teach 60 % of the lessons scheduled and extremely slow pace of work greatly affected the OTL. Thus they write: "Our most important findings relate to the significant relationship between the gain (the value-added) in learner achievement on our pre- and post-tests to the quality of their teachers' teaching pedagogy and the number of lessons their teacher taught on the test topics" (p. 7). Their executive summary concludes that SA schools for African children are "highly inefficient, at least in producing academic learning" (p. 7).

6 Localized qualitative research: illuminating complexity

Several smaller qualitative studies exploring the nature of the relationship between SES and mathematics learning (published mostly in education journals or conference proceedings) contribute meaningfully to our understanding of the complex interplay between factors. In contrast to the large-scale studies or broad synthesized reviews, these provide rich descriptions of and insights into the why and how of the relationship. Much of the research seeks to understand the underlying mechanisms at play. This research tends to be conducted by academics in universities rather than members of research organizations or government-funded review committees (as in much of the research discussed above).

Mathematics education research conducted in SA almost inevitably touches on issues of equity and redress when engaging with the contextual background of studies. A continually growing area of research with a particular view to understanding inequality in mathematics performance is the complex relationship between language and mathematics learning. This research tends to focus on low SES learners, as this majority of learners mostly learn in a language which they have little access to outside of schooling. The overlap between language of learning with SES and its effect on mathematics achievement is referred to in almost all of the large studies above. The data shows a complex picture that cannot easily be explained in terms of causal relationships. In terms of providing in-depth insights into the complex nature of this relationship, the work of Setati (e.g. 2005) and colleagues (e.g. Setati and Adler 2000; Setati et al. 2008; Barwell et al. 2007) has become nationally and internationally influential. They urge that multilingualism should be reconceptualized as a resource rather than a disadvantage, thus shifting the deficit discourse around multilingualism and mathematics performance towards a proficiency discourse. Most language 'factors' in large-scale studies correlate with low mathematics performance but, as suggested earlier, this should not be read as causal. Setati et al. (2008, p.14) write:

> What does it mean to teach or learn mathematics in a language that is not your home, first or main language? This is the situation in the majority of classrooms in South Africa. In these classrooms the language of learning and teaching (LoLT) is English – one of eleven official languages; however, neither the teacher nor the learners have English as their main, home or first language. Research shows that teachers and learners in these classrooms prefer that English be used as the LoLT.

Interestingly, English is chosen even while epistemological access is sacrificed and in this respect Setati (2005) argues: "for the need to recognize and acknowledge the political role of language when conducting research into the relationship between language and mathematics education in multilingual classrooms" (p. 447). This is a growing field of research in SA and continues to yield key insights into the complex relationship between mutilingualism, SES and learning.

A Bernstinian analysis of C2005 showed weakened boundaries between mathematics and everyday knowledge and the subject was renamed *Mathematics, Mathematical Literacy and Mathematical Sciences* (MLMMS). Teachers in low SES schools, with little access to support, particularly struggled to make sense of these changes, resulting in unintended further mathematics learning gaps between 'advantaged' and 'disadvantaged' learners (Graven 2002). Subsequent curriculum revisions have tightened the classification and the name MLMMS has reverted to *Mathematics*. Despite this tightening of classification in the mathematics curriculum, research conducted by Hoadley (e.g. Hoadley 2007, 2008; Hoadley and Ensor 2009) that focuses explicitly on the relationship between social class and pedagogic practice shows that learners from different SES backgrounds continue to be given differential access to learning. She writes:

> Everyday knowledge is often emphasized in the progressive agenda aimed at empowering learners and facilitating their access to school knowledge. However research points out that it is often the marginal groups (lower ability learners, working-class children) who are exposed to local, everyday knowledge, often at the expense of the more specialized knowledge of mathematics… Muller and Taylor (2000, p. 68) comment that "the lower ability student, paradoxically, is left free to be a local individual but a failed mathematics learner." (Hoadley 2007, p. 682)

These findings are in line with Taylor (1999) and Muller and Taylor (2000) but beg the need for further research as

to whether, in the same classroom, learners from a range of SES backgrounds are still given differentiated access. Jaffer and Davis (2012, p. 105), however, raise questions about the validity of the use to which the notion "orientation to meaning" is put in the literature; specifically, the distribution of "elaborated orientations to meaning" to middle-class students and of "restricted orientations to meaning" to working-class students. Their work provides exploratory alternative ways of examining the resources deployed by students from different social class backgrounds. Such work holds the promise of providing new lenses for examining the relationship between SES and mathematics learning/achievement.

Research by Feza-Piyose (2011) raises questions as to whether 'African' students coming into previously 'White' schools are given full access to learning. Her work (based on a case study of one teacher) argues that racism is at the heart of the problem. Racism is a prejudice that must be investigated, as is similarly argued by Danny Martin in the case of the USA (Valero et al. 2012) where SES is often used as a proxy for race. There are, however, several other prejudices that can influence teachers' expectations of learners and their provision of differentiated access to learning opportunities. For example, prejudices relating to learners' low English language proficiency, SES or health/disability status (e.g. HIV-positive, hearing impaired). The whole spectrum of prejudices requires investigation if we are to understand the complexity of the relationship between prejudices (many promoted under apartheid) and differential learning opportunities emerging.

Teachers' SES backgrounds are not homogenous across SA. For many teachers they are the only bread-winner in a large extended family, while for others their income is relatively insignificant to the finances of their family. In many cases teachers align with broader worker struggles and yet as employed educated professionals with relatively secure jobs their interests are quite different from worker needs. In this respect we need to consider the extent to which teachers' social class differentiation (educated and employed) might influence their relationship with learners whose parents are poor, uneducated and/or unemployed.

Another node of growing research focused on the challenges of poor mathematical performance of low SES learners, aimed at the dual goal of 'equity and excellence', is that of Adler (e.g. 2010) and colleagues (e.g. Adler and Davis 2006). This work proposes "strengthening our understanding of the mathematical work of teaching, what some refer to as mathematics for teaching" based on the assumption that this is "a critical dimension of enhancing its teaching and learning" (Adler 2010, p. 123). While this field is growing internationally and resonates strongly with common-sense assumptions of how to improve both mathematics teacher education and student performance, the review of large-scale studies discussed above indicates uncertainty as to the *extent* to which this factor, in relation to the many other impacting factors, makes a difference. In this respect perhaps we need to shift towards adopting a more holistic approach in our research and development where simultaneously a wide range of impacting factors are considered and we examine the way in which these factors interact to enable (or retard) progress.

7 Concluding remarks

Jurdak (2011) notes that a country's socio-economic status, human capital, educational capital and culture impact on mathematics education—not only as individual factors but through their interaction. He notes that where socio-economic divisions coincide with cultural divisions these would impact differently to a country where these did not coincide. In this paper I have illuminated, in the case of SA, the importance of understanding the specificities of context in which relationships between SES and performance emerge. I have argued that this understanding is critical to finding ways to address the equity crisis in mathematics education.

SA's extreme income inequality within a context of widespread and deep absolute poverty has not been sufficiently interrogated in terms of its impact on education. There are many poor countries, including our direct neighbours, achieving better mathematics performance. None of them have such high levels of inequality or a history in which the education of the majority of the people was deliberately and violently undermined (Chisholm and Chilisa 2012). As many studies acknowledge, we do not entirely understand what the impact of relative—as opposed to absolute—poverty does to educational outcomes. At an obvious level, having what many believe to be the largest gap between rich and poor in the world means that wealthy and middle-income learners access mostly private and ex-model C (formerly White) fee-paying schools. This group that has access to better-quality education for their children includes almost the entire political elite in SA and, ironically, children of some teachers in the public sector. Teachers, along with small-business owners, police, civil servants and nurses, are the main utilizers of the low-fee private schools mushrooming across the country (Bernstein and Schirmer 2010). This rapid rise of low-fee schools (similar to India) serves to further commercialize education in SA and draws teachers away from state schools, thus exacerbating the problem.

As Wilkinson and Pickett (2009) have argued, unequal societies do much worse on a wide range of measures, including educational performance. In a vicious cycle, poor education directly contributes to rising levels of inequality

in SA's skill shortage in almost every industry. This skills shortage pushes up wages for the skilled, driving the Gini coefficient to almost 0.7 (the United Nations international "alarm line" for inequality is 0.4). No other country has sustained such high levels of inequality for so long. A deeper understanding of inequality as a core component of SES, and not just of the nature and impact of poverty, should enrich our understanding of the relationship of SES to mathematical educational outcomes.

Similarly, no country shares our recent apartheid history that systematically disempowered people politically, economically, socially and educationally. Fleisch's concept of 'dependent poverty' is a useful attempt to historicize poverty in South Africa. Most studies, I have argued, are not sufficiently concerned with the impact of apartheid in terms of its promotion and entrenchment of dispositions of compliant, passive and dependent learners, teachers and citizens. These dispositions are seemingly in opposition to developing critical creative and actively participating mathematics problem solvers as envisioned in our new curriculum. Chisholm and Chilisa (2012) point to the rapid disruptive nature of South African curriculum revisions without sufficient attention to teacher development as compounding the problem. The foregrounding of the specificities of the SA context begins to move the research forward in finding solutions specific to the problems in our context, as opposed to adopting strategies for addressing educational performance adopted by top-performing countries.

While large- and medium-scale studies consistently point to a positive correlation between factors connected with SES and mathematical performance, they do not sufficiently explain or explore the complex way in which these factors interact to impact on differential performance. Nor do they explore how the interplay of factors shifts across contexts. For example, we need to ask: What interrelationship of factors enables high SES school contexts to 'compensate' for negatively impacting factors of individual low SES learners? What is the relationship of factors in Non-Governmental Organization intervention projects that enables improved performance for low SES learners? Penreach (2011) argues that their holistic approach from ECD to careers, and their focus on community agency, enables their strong improvement in mathematics. Perhaps some factors are strengthened by the inclusion of other factors; and the absence of certain factors might render intervention focused on single factors ineffective. As with research into nutritional combinations that optimize absorption of essential vitamins, perhaps we need to focus our research on understanding how various combinations of factors might enable improved learner performance—the whole can be more than the sum of its parts.

Additionally, it is important to consider the ethics of our research. In many studies the voices of teachers, parents and students are largely absent. It is critical that researchers seek to tell stories of educational opportunities and success in relation to low SES learners, low SES schools and learner performance so as to counter the pervasive message of hopelessness and inevitable failure that permeates correlation studies. While societal inequality must be reduced in order to support educational equity and quality *for all*, and as citizens we must push our politicians and society for this to happen, we cannot wait for this. As researchers we need to play our part in examining the spaces within the current 'crisis' that enable those from low SES backgrounds and schools to challenge the 'inevitability' implied by correlation findings. I was reminded the other day of the well-known Nigerian saying, 'It takes a village to raise a child.' This, I believe, is pertinent to our crisis. We can no longer as educators and citizens wait for someone else to 'fix it'. We need to 'get involved': whether running an after-school mathematics club, delivering water to schools or sharing educational success stories within contexts of poverty. Additionally we need to consider the effects of our research and question whether it contributes to finding ways forward. If our research aims to confirm the extent of the crisis and communicates messages of deficit and inevitability of failure for the poor, then we need to begin to question the ethics of our participation in such research.

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