The Performance of South African Schools: Implications for Economic Development

by

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Declaration

By submitting this thesis/dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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ABSTRACT

At the time of South Africa's transition to democracy the school system was envisaged to be a powerful vehicle for nation-building and transformation. The chronic low performance of the South African school system has subsequently become the subject of widespread public concern. This thesis examines the distribution of cognitive achievement amongst South African children and the factors influencing it, especially socio-economic status, and asks what the implications of this are for future economic development. The methodologies employed are predominantly quantitative as various sources of data are examined in order to collect evidence pertaining to the question above.

Chapter 1 lays down a conceptual framework for understanding the role of schooling in economic development. The point is made that although education is often envisaged as a vehicle for development and mobility out of poverty, the home socio-economic status of children impacts significantly on their educational outcomes. Chapter 2 reviews recent and relevant literature to establish main currents of thinking regarding the influence of socio-economic status on educational outcomes. Chapter 3 follows this with an empirical examination of the influence of socio-economic status on reading achievement amongst South African children. The results indicate that the relationship between socio-economic status and educational achievement in South Africa is particularly strong by international standards. Furthermore, the historical divisions within the school system remain key to understanding continuing inequalities in educational outcomes. The socio-economic status of students is crucial in determining which part of the school system students enter; then for those entering the historically disadvantaged system the chances of achieving high quality educational outcomes are small, regardless of their home background.

The main priority in the latter part of chapter 3 and thereafter is the attempt to identify factors that improve cognitive achievement, given the socio-economic context of schools and their students. In chapter 4, this search is taken up by examining a rich collection of data regarding school and teacher practices in South African primary schools. In chapter 5 this is done by analysing trends in the ability of high schools to convert demonstrated grade 8 achievement into matric outcomes. An additional perspective is provided through a comparison of the performance of South Africa's independent and public schools in Chapter 6. The final chapter

summarises the results from these various approaches and highlights several key areas on which, it is recommended, attempts to improve South Africa's schools should focus. These include the management of school resources, teacher work ethic, time management and planning within schools, curriculum coverage, the accuracy of assessment and feedback to students, and parent commitment to education. Improving these areas within the large and struggling part of the South African school system will be decisive for the country's economic development.

OPSOMMING

Ten tye van Suid-Afrika se demokratiese oorgang is die skoolstelsel as ’n sterk instrument vir nasiebou en transformasie gesien. Die kroniese swak vertoning van die Suid-Afrikaanse skoolstelsel het sedertdien tot wye openbare besorgdheid gelei. Hierdie proefskrif ondersoek die verdeling van kognitiewe prestasie onder Suid-Afrikaanse kinders en die faktore wat dit beïnvloed, veral sosio-ekonomiese status, asook die implikasies daarvan vir toekomstige ekonomiese ontwikkeling. Die metodologie wat gebruik word, is hoofsaaklik kwantitatief, want verskeie databronne word ondersoek om getuienis in te win rakende bogenoemde vraagstuk.

Hoofstuk 1 stel ’n konseptuele raamwerk daar om die rol van onderwys in ekonomiese ontwikkeling te verstaan. Die punt word gemaak dat, alhoewel onderwys dikwels as ’n instrument vir ontwikkeling en uitstyging uit armoede gesien word, die sosio-ekonomiese status van kinders se huislike omgewing hulle onderwysuitkomste beduidend beïnvloed. Hoofstuk 2 bied ’n oorsig van onlangse en relevante literatuur om die hoofstrome van denke oor die invloed van sosio-ekonomiese status op onderwysuitkomste aan te dui. Hoofstuk 3 volg dit op met ‘n empiriese ontleding van die invloed van sosio-ekonomiese status op leesvaardigheid onder Suid-Afrikaanse kinders. Die resultate dui daarop dat die verband tussen sosio-ekonomiese status en onderwysuitkomste volgens internasionale standaarde in Suid-Afrika besonder sterk is. Verder is die historiese verdelingslyne binne die skoolstelsel van sleutelbelang om voortgesette ongelykheid in onderwysuitkomste te verstaan. Die sosio-ekonomiese status van studente bepaal grootliks tot watter deel van die skoolstelsel kinders toegang kry. Vir daardie kinders wat in die histories-afgeskeepte deel van die stelsel beland, is die waarskynlikheid van hoë gehalte onderwys klein, ongeag hulle gesinsagtergrond.

Die klem in die laaste gedeelte van hoofstuk 3 en daarna val daarop om faktore te identifiseer wat kognitiewe uitkomste verbeter, gegewe die sosio-ekonomiese konteks van skole en studente. In hoofstuk 4 word hierdie speurtog voortgesit deur ’n ryk verskeidenheid data rakende skole en onderwysers se praktyke in Suid-Afrikaanse laerskole te ondersoek. In hoofstuk 5 word dit gedoen deur ’n analise van die vermoë van hoërskole om graad 8-vlak prestasie in graad matriekuitkomste te omskep. ’n Vergelyking van die prestasie van Suid-Afrika se onafhanklike skole met openbare skole in hoofstuk 6 bied verdere perspektief hierop. Die finale hoofstuk som die bevindinge van hierdie verskillende benaderings op en belig sekere sleutelaspekte waarop

pogings om Suid-Afrika se skole te verbeter klem behoort te lê. Dit sluit in bestuur van skoolhulpbronne, onderwysers se werksetiek, tydsbestuur en beplanning binne skole, dekking van die kurrikulum, die akkuraatheid van assessering en terugvoer daaroor aan studente, en ouers se betrokkenheid by onderwys. Verbetering op hierdie gebiede binne die groot, sukkelende deel van die Suid-Afrikaanse skoolstelsel sal deurslaggewend wees vir die land se ekonomiese ontwikkeling.

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LIST OF ABBREVIATIONS

SES – Socio-economic status

HOA – House of Assemblies (former education department for white schools)

HOR – House of Representatives (former education department for coloured schools)

HOD – House of Delegates (former education department for Indian schools)

DET – Department of Education and Training (former education department for black schools)

OBE – Outcomes Based Education

TIMSS – Trends in International Maths and Science Study

PIRLS – Progress in International Reading Literacy Study

SACMEQ – The Southern and Eastern African Consortium for Monitoring Educational Quality

NSES – National School Effectiveness Study

HLM - Hierarchical Linear Modelling

OLS – Ordinary Least Squares

IEA - International Association for the Evaluation of Educational Achievement

PCA - Principal Component Analysis

ECD - Early Childhood Development

LTSM – Learning and Teaching Support Materials

DoE – Department of Education

HSRC – Human Sciences Research Council

SGB – School Governing Body

CHAPTER 1: INTRODUCTION

1.1) Education and Economic Development

> "Every state is a community of some kind, and every community is established with a view to some good; for mankind always act in order to obtain that which they think good."
>
> - Aristotle

Classic and contemporary political philosophers have long been occupied with the pursuit of the "good society", what it should look like and what principles should govern it. Most coherent political philosophies ascribe to education the task of creating citizens who will cooperate towards the fulfilment of the good society, however that is conceived. In Plato's version of the good society the guardians and plebeians would receive very different educations in preparation for their roles in society. Specific types of activities, carefully selected literature and even the telling of a "noble lie" would ensure that citizens believed in the society and accepted their ascribed roles. Political philosophies and utopian visions generally either expect education to reproduce an existing and desirable order or assign an emancipatory function to education by which society is transformed into the good society.

Many education systems of today, including South Africa's, have the explicit purpose of educating for democracy. Twentieth century thinking on education and democracy has been strongly influenced by John Dewey. For him democracy was more than a political system. It was a "mode of open association and communication between individuals and groups" (Dewey, 1916, quoted in Brown and Lauder, 2001: 61). Schools, by this view, should promote this through integrating children from diverse origins and parts of society and teaching them to develop respect for each other's points of views. The South African Schools Act of 1996 demonstrates that schools in this country are expected to foster democracy as well as several other freedoms, including economic freedoms:

> *"[T]his country requires a new national system for schools which will redress past injustices in educational provision, provide an education of progressively high quality for all learners and in so doing lay a strong foundation for the development of all our people's talents and capabilities, advance the democratic*

transformation of society, combat racism and sexism and all other forms of unfair discrimination and intolerance, contribute to the eradication of poverty and the economic well-being of society…"

- Preamble to the South African Schools Act (South Africa, 1996)

Conceptions of the good society, including democracy, often uphold freedom as an appropriate end. According to Hattersley (2004: 12), "the good society promotes the greatest possible degree of freedom for the largest possible number of people." The concern with freedom and liberty, fundamental to modern democracies, owes its heritage to the social contractarian tradition of political philosophy (Hobbes, Locke and Rousseau). The departure point for the contractarians is a consideration of the "state of nature". This situation is the anarchist's utopia in which every man is his own master. Having different conceptions of what the state of nature looks like, the contractarians agree that those in the state of nature would realise their mutual need for a social authority. The agreement by which this takes place is called the social contract. [1]

As James Buchanan, a libertarian and (new) contractarian by his own admission, suggests, liberty is limited by the inescapable need for an institutionalised authority (Buchanan, 1975: 6-7). The contractarian justification of authority revolves around the idea that individual liberty should be maximised but that one person's liberty should not encroach upon another's. The protection of individuals' private domains of liberty is what Isaiah Berlin (1998[1958]) has called "negative freedom". It is only when negative freedoms are guaranteed that an economy based on decentralised cooperation can flourish. Secure property rights and the rule of law, for example, are necessary to create an environment of trust and protection conducive to forward-planning and cooperation amongst individuals trading their goods and skills (Du Plessis, 2003, Greenspan, 2007). Yet the formal protection of individual liberties is surely not enough to guarantee freedom. Christine Korsgaard (1993: 58) argues that, "the poor, the jobless, the medically neglected, the unhoused and the uneducated are not free no matter what rights they have been guaranteed in the constitution." Thus a concern with positive freedom arises. Positive freedoms, such as a minimum standard of living, empower individuals to participate more fully in society (Du Plessis, 2004: 6).

[1] The "state of nature" refers to an actual historical or hypothetical situation prior to the existence of any authority or group cooperation. Similarly, the social contract was thought by some contractarians to be an actual historical agreement, while others consider it to be an implicit agreement or even concede it to be purely hypothetical.

The notion of positive freedoms is closely related to Amartya Sen's capabilities approach to freedom. Life, in Sen's philosophy, consists of "doings or beings", which he calls "functionings" (Sen, 1997a: 199). These range from being well nourished to having self-respect. "Capability" is the ability to achieve these functionings, or the freedom to live as one chooses. Development, then, is the "process of expanding substantive freedoms that people have" (Sen, 1999: 297). Sen emphasises that many connections exist between capabilities. For example, illiteracy and under-nourishment are often results of low income. And yet conversely, education and good health are important determinants of income (Sen, 1999: 19). This interdependency underlies Sen's bold claim that freedoms are both the end and the principal means of development.

This thesis uses Sen's view of development, in the sense of expanding human capabilities and freedoms, to augment the more traditional notion of economic development. The latter is distinct from economic growth, which is the positive trend in a nation's real total output or GDP, although there is a view that growth is the key to economic development. Robert Lucas (quoted in Ray, 1998: 7), for example, writes, "By the problem of economic development I mean simply the problem of accounting for the observed pattern, across countries and across time, in levels and rates of growth of *per capita* income." If this were a definition of economic development it would be narrow and incomplete. It is rather a view of how development happens – that the characteristics of development, such as health, sanitation, literacy and life expectancy, are all enabled by economic growth. Meier (1995: 7) defines economic development as long-term *per capita* income growth that leads to qualitative improvements throughout the social system. Development thus involves "growth plus change". This definition of economic development needs to be expanded to incorporate Sen's insights. Economic development can then be viewed as a complex process in which features such as *per capita* income, health, family stability and education have an interdependent relationship and in which causality is often multi-directional.

Todaro (2000: 8) emphasizes that the field of development economics is especially concerned with improving living conditions amongst the underdeveloped and poverty-stricken parts of society. A special consideration of the poor is also central in most theories of social and economic justice. Perhaps the most influential theory of justice of the Twentieth Century has been that of John Rawls. Using a social contractarian approach, Rawls (1971) develops his two principles of justice according to which everyone should equally be guaranteed certain basic liberties, and social and economic inequalities are permitted in so far as this improves the material position of the worst-off.

A strong case can be made that the world has undergone a remarkable phase of economic development over the last 200 years. The spectacular rise in living standards ever since the Industrial Revolution has been well documented (e.g. Dornbusch, 1999; Easterlin, 2000; Masson, 2001; Wolf, 2004). There has been an exponential rise in real *per capita* income in most parts of the world, although Africa has lagged behind, growing at a considerably slower rate. New technologies and reduced transport costs have contributed to the spread of higher living standards, including such fundamental elements as infant mortality, adult literacy and life expectancy. For example, life expectancy in England rose from 41 years in 1800 to 77 years in 1999. For developing countries it rose from 26 years as recently as 1900 to 64 years in 1999 (Wolf, 2004: 43-45). Such advances constitute a considerable expansion of the substantive freedoms people have to live the kind of life they have reason to choose.

Wider participation in education is itself one of the benefits of this remarkable economic development. It is significant that Education for All (EFA) is now a foreseeable reality and is one of the United Nations' Millenium Development Goals. As access to education becomes universal a more pertinent constraint to human capability in many parts of the world, including South Africa, is now the quality of education. This is an important barrier to development in South Africa and is described throughout this thesis.

Education is also recognised as a means to economic development. Owing largely to the work of Theodore Schultz and Gary Becker, the role of education as a means to development has been framed by the notion of human capital in the economics of education literature, which has burgeoned in the wake of their seminal contributions (Schultz, 1961; Becker, 1962, 1964). Schultz, in his presidential address to the American Economic Association, suggested that, "skills and knowledge are a form of capital," and that "this capital is in substantial part a product of deliberate investment" (Schultz, 1961: 1). There are strong theoretical reasons to expect an investment in the human capital of a nation to promote economic growth. Greater human capital should improve the productivity of the labour force, increase the innovative capacity of the economy and facilitate the transmission of new knowledge and technologies. This has been tested empirically in the literature on growth modelling. For example, Mankiw, Romer and Weil

(1992) introduced the accumulation of human capital into the Solow model for economic growth. They argue that their augmented model provides a better description of actual trends in economic growth across countries.

At the level of the individual, too, the human capital model provides a framework for explaining how investments in education can draw people into the stream of development and increase their human capability. According to the human capital model, education improves an individual's productivity, which in turn is rewarded on the labour market by higher earnings.[2] Consequently, a vast literature has developed, following in the tradition of Jacob Mincer (1974), which estimates the labour market returns to education. Such a large volume of work using "earnings functions" has been produced that Heckman, Lochner and Todd (2005: 3) claim that "earnings functions are the most widely used empirical equations in labour economics and the economics of education." The literature has consistently demonstrated that the probability of employment, and earnings conditional upon employment, increase with years of education. Recent attempts to account for the quality of education (often measured by demonstrated skills) have suggested that this may be even more important than years of education (Murnane *et al*, 2001; Hanushek and Woessman, 2007). Education quality therefore has an important role to play in economic development.

1.2) Education and Economic Development in South Africa

Given what is known about the "human capital" impact of education on labour market success, as well as the broader impacts of education on human capability, what contribution can one reasonably expect the South African school system to make toward economic development in this country? That is the central question of this thesis. Several empirical issues together determine the potential effectiveness of a school system in promoting economic development. Firstly, how effective is the school system at producing educational outcomes that empower students with the skills and qualifications necessary to participate successfully in an economy

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2 Human capital is distinct from human capability, as Sen (1997b) himself explains. Human capital is concerned with the agency of people to enhance economic growth or personal earnings through greater skill and knowledge. Human capability is concerned with the ability of people to live in ways they would choose. Sen (1997b) does not suggest that these are rivalrous concepts but observes that human capability is simply broader. Education, in so far as it increases human capital, provides an indirect means to human capability. Yet the benefits of education exceed those which can be construed as human capital. The ability to make more informed choices or to be respected by others directly enhances one's ability to function in society, even if there is no associated increase in productivity.

characterised by decentralised cooperation? A generally low standard of schooling will constrain development. Secondly, to what extent does socio-economic status (SES) influence educational outcomes? If poverty severely undermines the ability of poor students to achieve educationally, this too will restrict economic development. Thirdly, what can schools do to improve educational outcomes in the context of educationally disadvantageous factors like poverty, and how considerable are these effects likely to be? This thesis uses various sources of data and techniques to assess the evidence pertaining to these three questions.

The South African education system and the state of economic development must be understood in the context of the country's unique history. The notorious policy of apartheid was itself preceded by many years of segregationist policies and colonialism. Institutionalised discrimination resulting in under-development for much of the population, therefore, goes back much further than a mere generation or two. As one commentator has characterised it, South Africa suffered under "Three hundred years of inequality."[3] What distinguished apartheid, which literally means "separateness", was its explicit ideological content leading to an intensification of discriminatory policies, and that it ran against the grain of moral, political and practical international trends. Despite a rhetorical commitment to development implied by the policy of "separate development", the apartheid policies had a regressive impact on the distribution of income along racial lines. The Group Areas Act (1950) and the homelands policy restricted the possibilities of land ownership and residential location for non-white South Africans. Labour market policies reserved certain of the more highly skilled professions and jobs for whites.

The apartheid system of "native education" quite explicitly aimed to prepare people for an unequal labour market. As the (then) Prime Minister Verwoerd explained it, "What is the use of teaching a Bantu child mathematics when it cannot use it in practice?"[4] The ultimate purpose of education for non-whites under the Bantu Education Act of 1953 was to protect and reinforce the privileged political and economic position of whites and to keep non-whites under control. As a consequence there were different curricula, highly unequal funding and separate departments of education for each race group.[5] To compound things, schools attended by black students became sites of resistance to apartheid, with detrimental effects on the amount of

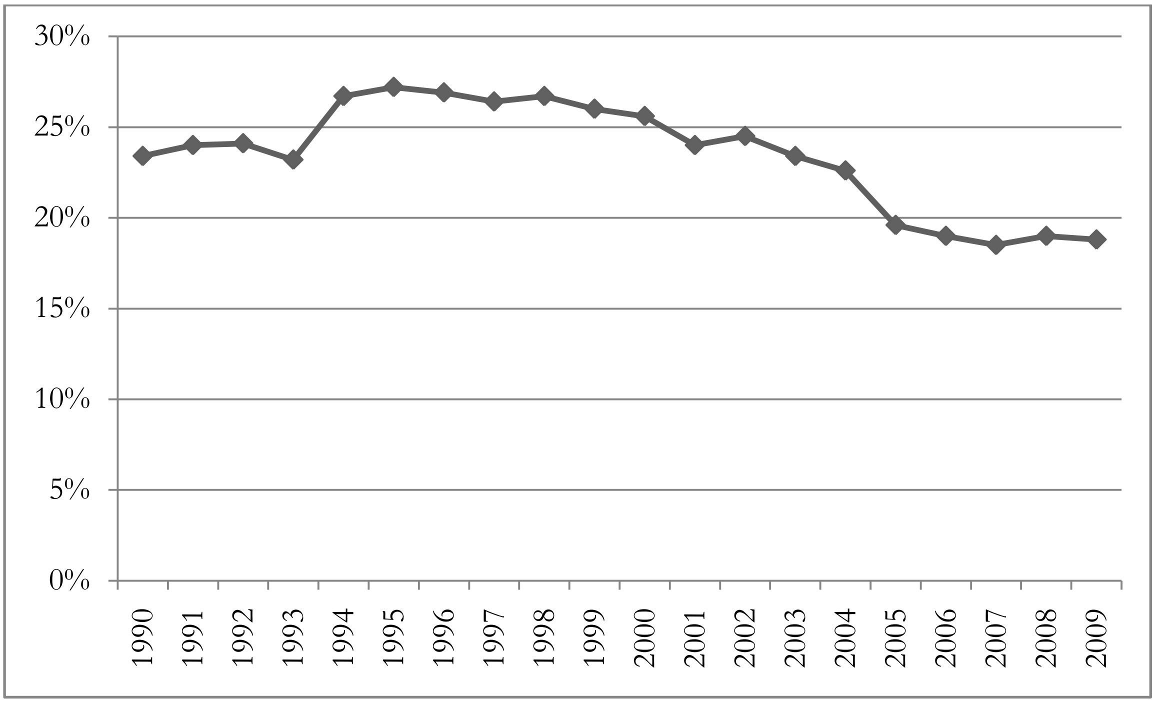
[3] This is the title of a book by Sampie Terreblanche.
[4] Quoted in Fiske and Ladd (2004: 42).
[5] Under the apartheid system there were separate education departments corresponding to the various race groups in South Africa. There were separate departments for white schools (House of Assemblies – HOA), coloured schools (House of Representatives – HOR), Indian schools (House of Delegates – HOD) and black schools (Department of Education and Training – DET) and each of the homelands had an education department.

learning that occurred, thus adding to the educational backlog that would face a new democratic South Africa.

The institutions and policies governing education in South Africa underwent dramatic changes with the transition to democracy in 1994. The racially separated administrations were consolidated into a unified national Department of Education. At the same time the nine provincial governments were also given considerable authority, especially with regard to administering education spending. Public spending on education as a proportion of GDP has been on a declining trend in recent years. Education spending as a proportion of GDP has decreased from about 6% in 1998 to just over 5% in 2008, although this remains high by international standards (Gustafsson, 2010). This comparably high figure for South Africa is largely pushed up by two factors: high enrolment and high teacher salaries relative to GDP *per capita*. Teacher pay remains the dominant component in education spending, despite the fact that personnel spending as a proportion of total education spending has decreased from about 90% in the late 1990's to about 80% (OECD, 2008: 43). The declining education spending to GDP ratio masks the fact that spending per student has nevertheless increased in real terms. In constant 2004 rands, school expenditure per student has increased from about R3400 in 1987 to over R5000 in 2007 at a fairly stable rate of increase. The decreasing education spending to GDP ratio reflects the fact that GDP grew faster than education spending over the period.

Similarly, education spending as a proportion of total government spending has been on the decline. Figure 1.1 shows that after an initial prioritisation of education spending in 1994, the share of government expenditure devoted to education has declined from about 27% to below 19% in 2009. To some extent this may reflect the implementation of new forms of social spending, notably the introduction and expansion of various social grants, and the need to respond to other service delivery pressures.

Figure 1.1: Education expenditure as a proportion of total national and provincial government expenditure



Sources: Buckland and Fielden (1994); Annual Budget Reviews (1995-2010)

When considering the targeting of funds, it is clear that government spending on education has become equitable and even progressive. Initially though, greater equity in spending did not translate into real resource shifts as the increase in spending went mainly to raising teacher salaries in the historically disadvantaged part of the school system (Van der Berg, 2007: 871). By 2002, greater real resource shifts had been accomplished. The number of teachers paid by the state had increased from 24 to 31 per 1000 students in historically black schools, and decreased from 59 to 31 per 1000 students in historically white schools (Van der Berg, 2007: 872).

Non-personnel funding actually received by schools is pro-poor but not as pro-poor as policy has stipulated it should be. According to the Norms and Standards for non-personnel spending introduced in 2000 (and amended in 2006), schools have been divided into poverty quintiles with the poorer quintiles receiving a higher allocation of non-personnel funds. Moreover, the poorest 40% of schools have become so-called "no-fee schools", according to which greater funding is made available to them on condition that school fees are abolished. Table 1.1 shows the targeted amounts of per student non-personnel spending for each quintile according to the funding norms as specified in Government Notice 869 of 2006. It is clear that the policy has a strong pro-poor design with intended spending on quintile 1 approximately six times greater than that on quintile 5. Actual funding received by schools is indeed pro-poor but not as strongly so, as the top row shows.

Table 1.1: Median total department spending by school poverty quintile (rands)

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
Actual	711	711	481	474	228	591
Target	775	711	581	388	129	517

Source: South Africa (2009a: 39)[6]

Several factors may account for the discrepancy between budgeted non-personnel spending and the actual amounts received by schools. According to the Department of Education (2009a: 50), there is some evidence of crowding out of non-personnel spending by personnel spending, i.e. financial transfers that were intended for non-personnel spending instead are used by schools to supplement personnel spending. In addition, school principals have pointed to other inefficiencies in the allocation of funding: financial transfers coming through late, receiving departmentally purchased goods and services too late and receiving goods and services not well matched to their school's needs (South Africa, 2009a: 87).

The total expenditure per student excluding what the state spends on teacher salaries consists of spending by the school (funded by fees and financial transfers from government) and departmental purchases. Table 1.2 shows this amount by school poverty quintile. The effect of private spending is considerable in quintile 5 schools but results in a similar amount of spending per student in the bottom four quintiles. In summary, non-personnel spending norms aim for approximately six times as much on quintile 1 schools than quintile 5 schools. In reality quintile 1 schools receive about three times that received by quintile 5 schools. Including private spending from school fees, the total expenditure per student is roughly three times as much in quintile 5 schools as that in quintile 1.

[6] Based on a UNICEF and USAID funded study conducted for the Department of Education in 2009, which collected detailed information on funding in 525 public schools.

Table 1.2: Median school expenditure per student plus departmental purchases (rands)

Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Total
981	944	1062	1105	2829	1673

Source: South Africa (2009a: 47)

Analyses of fiscal incidence have confirmed that government expenditure on schooling has become more redistributive between 1996 and 2006 (Van der Berg, 2006, 2009; Gustafsson and Patel, 2006). Greater fiscal equity has also lead to improvements in the provision of Learning Support Materials and school infrastructure, although some shortages in these areas persist. A survey conducted by the Fiscal and Financial Commission revealed that the allocation of Learning and Teaching Support Materials (LTSM) differed between students within schools. It was found that many schools permit textbook shortages in grades 8-11 in order to prioritise textbooks for grade 12 students in view of the pressure on schools to perform well in the matric examination, which is the school leaving examination at the end of grade 12 (OECD, 2008: 82). Improvements in school infrastructure between 1996 and 2006 have been impressive: the number of schools with electricity nearly doubled; the number of schools without water more than halved; and the number of schools without toilets also halved (OECD, 2008: 107). Further improvements will be necessary in these areas as well as other aspects of school infrastructure, especially the provision of libraries, computers and science laboratories.

These substantial investments in South African schooling warrant careful consideration of the outcomes being achieved by the school system. This is where the economic impetus behind an investigation into the performance of South African schools arises. At the heart of economics lies the basic problem of how best to allocate scarce resources amongst unlimited desires. It is therefore important to assess the effects of the resources being invested into South African schooling. Moreover, given that spending on education has increasingly been targeted toward the historically disadvantaged part of the system, it is important to know whether any observable improvement in the educational outcomes of this part of the system has been achieved.

What exactly the desired outcomes of schooling should be are not immediately obvious. Very often educational outcomes include indicators such as attainment, enrolment and student achievement as measured by test scores. Of course, many less easily measured benefits are also intended to accrue from education, such as good citizenship, socialisation and interpersonal skills. The difficulty in measuring these outcomes in no way detracts from their potential value. However, student achievement as measured by test scores is used as a measure of educational outcomes.

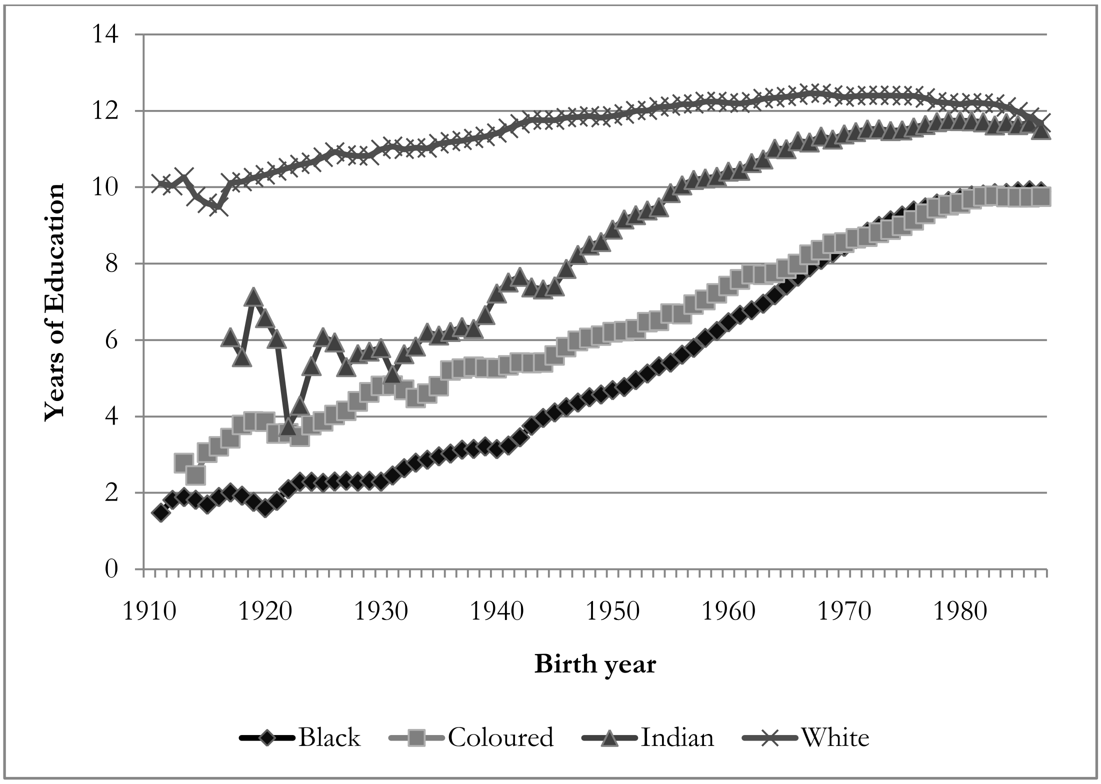
Another major component of education policy since 1994 has been curriculum reform. In an attempt to make a radical ideological break from the past, *Curriculum 2005* was drawn up with the explicit purposes of nation-building, promoting the constitution and fostering inclusive education. The result was a "new, innovative, rights-based national curriculum, based on the principles of Outcomes Based Education (OBE)" that was generally well received by the public (South Africa, 2009b: 12). The new curriculum was first implemented in 1998, but was soon met by criticism on theoretical grounds and based on worrying feedback about student learning in key areas such as reading, writing and counting (e.g. Jansen, 1999). Some of the fundamental problems with *Curriculum 2005* included a lack of clarity in its design, language, terminology and assessment requirements, a lack of specified content or use of textbooks, and a lack of support and training for teachers in implementing the curriculum (South Africa, 2009b). These factors led to a revision of *Curriculum 2005* during 2001. The *Revised National Curriculum Statement,* however, still suffered from confusion and many of the same problems as before. At the time of writing, the curriculum is again in review with the stated intention to further simplify and improve the national curriculum statement.

The most negative testimony against the curriculum has been the consistently poor performance of South African children in key learning areas such as reading, mathematics and science. This has been repeatedly attested by a range of domestic as well as international surveys. The Systemic Evaluation undertaken by the Department of Education (DoE) in 2001 tested 51 000 grade 3 students across the nation. The average score in numeracy was 30% and in literacy was 54% (Fleisch, 2008: 4). The evaluation of the Quality Learning Project (QLP) conducted by the HSRC at the high school level and the grade 3 and grade 6 testing done by JET Education Services confirmed that children were performing well below the standards required by the curriculum (Taylor, Muller and Vinjevold, 2003). In large cross country evaluations the performance of South African children has been dismal. In the Trends in International Mathematics and Science Study (TIMSS) of 2002, grade 8 South African students achieved the lowest average scores in both mathematics and science out of 46 countries, including six African countries. More recently and at the primary school level, South Africa came last in the Progress in International Reading Literacy Study (PIRLS 2006) out of 40 countries. In the Southern and East African Consortium for Monitoring Education Quality survey of 2000 (SACMEQ II), South Africa performed slightly below the average of 14 Southern and East African countries in grade 6 mathematics and reading.

The overall educational achievement of South African children conceals a sharp quality divide between two very differently performing parts of the school system. Following the logic of the "two nations" metaphor of Thabo Mbeki, Fleisch (2008: 1-2) describes the characteristic features of these two "systems". The well-functioning system consists of mainly historically white and Indian schools, is well resourced, serves middle class children of all race groups and produces a level of achievement that is comparable to that of most middle class children around the world. The second and much larger system enrols poorer children who are further disadvantaged through being located in schools which are themselves deficient. Students in this system have limited fluency in reading and writing and can perform only simple numerical operations (Fleisch, 2008: 2). The majority of university entrants are produced by the well-functioning system. Van der Berg (2007: 859) found that one in 10 white students achieved A-aggregates in the 2003 matric examination, whereas only one in 1000 black students achieved A-aggregates. Furthermore, nearly half of those black students that did achieve A-aggregates were in historically white and Indian schools. This division in the school system and the inequalities in South Africa's educational achievement are investigated extensively in Chapter 3, and set the context throughout this thesis.

The human capital challenge in South Africa is therefore definitely a matter of the quality of education. Attainment gaps between race groups have diminished considerably over the past few decades, even prior to 1994. Figure 1.2 shows the mean years of education attained for each birth cohort of South Africans by race. It is clear that average attainment is substantially higher amongst younger cohorts of black, coloured and Indian South Africans. The challenge now is to reduce the persistent inequalities in educational quality.

Figure 1.2: Educational attainment by race group (3 year moving averages)

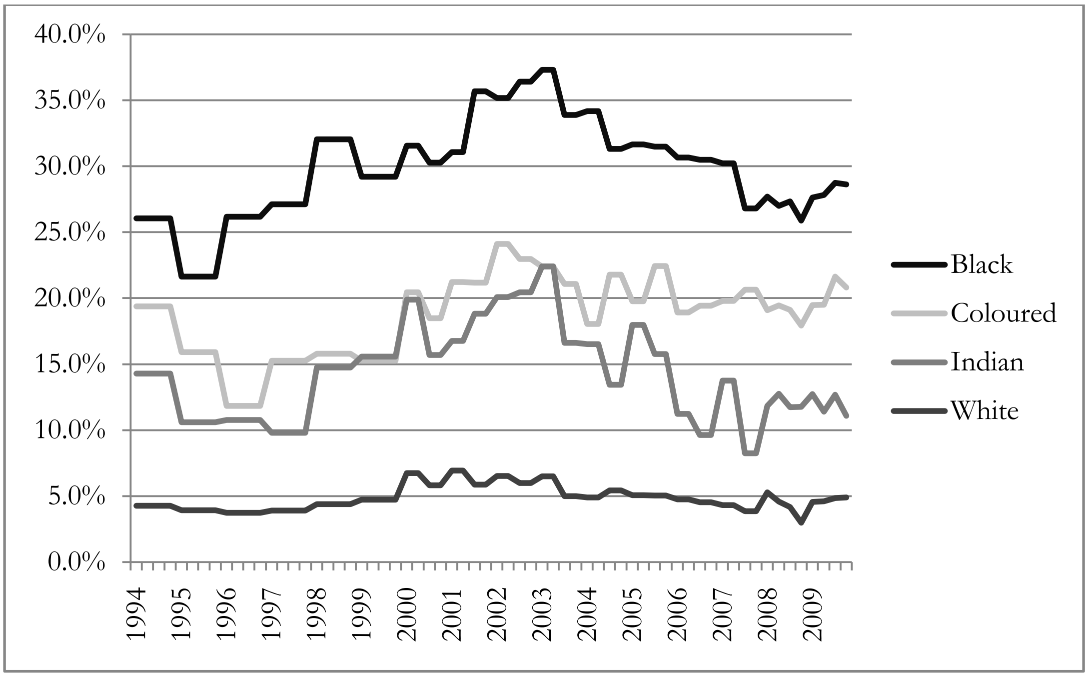


Source: Own calculations based on Community Survey (2007)

Problems with school quality present a two-tiered need to build human capital for the sake of economic development in South Africa, as Taylor (2007: 537) suggests. Firstly, economic growth is constrained by skills shortages, especially in the engineering sector. Pauw, Oosthuizen and Van der Westhuizen (2006: 14) maintain that firms, policy-makers and government are all in agreement that skills shortages represent the most important threat to accelerated growth in South Africa. Despite the existence of high unemployment, and even graduate unemployment, the economy is still short of specific high level skills. Taylor (2007: 537) argues that the most efficient way to address the skills shortages is to focus on improving already moderately and well-performing schools. But this would not address the second tier of the human capital challenge: the need to improve quality in the large poorly performing section of the school system. Children in these schools require an education that genuinely represents a pathway out of poverty and into fuller participation in society and economic life.

Van der Berg, Louw and du Toit (2009) have shown that poverty in South Africa has been declining somewhat in recent years. However, they argue that this is largely attributable to the expansion of the social grant programme rather than to improvements in education or health. Despite the recent modest decline, poverty remains severe in many parts of South Africa and is most prevalent amongst black South Africans. Unemployment too continues to be high with strong racial dimensions. Figure 1.3 demonstrates that the incidence of unemployment has consistently been highest amongst black South Africans. These large employment gaps have persisted despite the implementation of an ambitious set of affirmative action policies in the labour market. Burger and Jafta (2006) argue that racial employment gaps, which are substantial even at constant levels of educational attainment, are in all likelihood largely attributable to differences in the quality of education that is being received by the different race groups.

Figure 1.3: Strict unemployment by race in South Africa since 1994

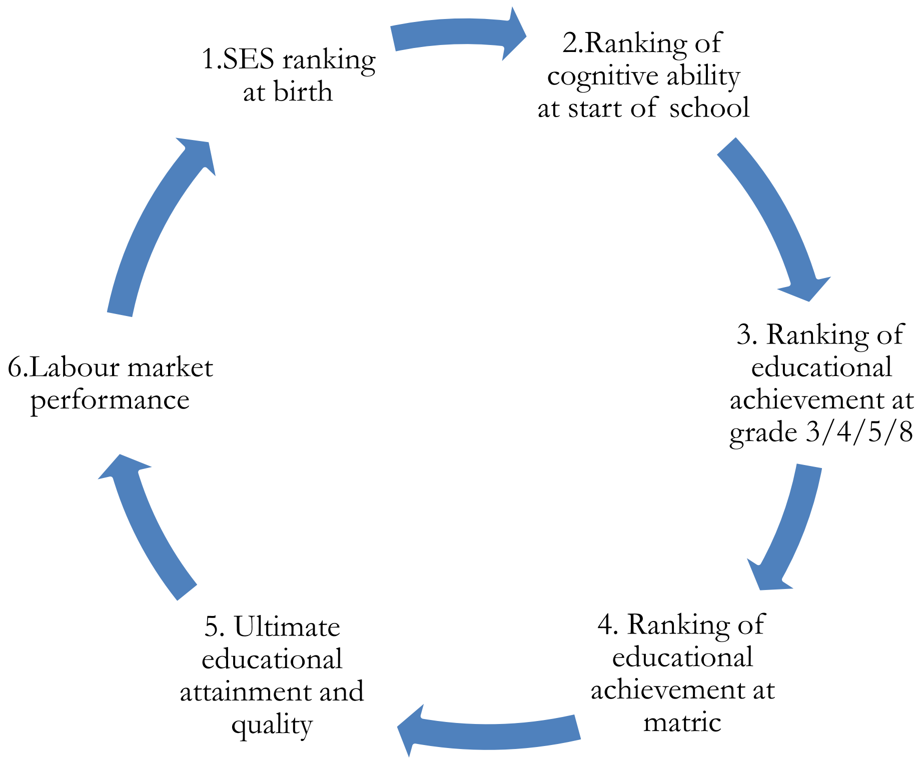


Source: October Household Surveys (1994 – 1999), Labour Force Surveys (2000 – 2009)

1.3) A research response: Overview of this thesis

Although education is widely regarded as a key mechanism for bringing about transformation, a reduction in unemployment and the "eradication of poverty", as the preamble to the South African Schools Act declares, there is an element of circularity at work. This is because the home background of students, in particular their SES, has a significant impact on educational outcomes. This is true in every society but the strength of the relationship varies considerably across societies. The extent to which children from disadvantaged backgrounds have a real opportunity to achieve educational outcomes that will enable them to be successful in the labour market is one indication of whether the school system can be expected to transform existing patterns of inequality or merely reproduce them.[7] The circular relationship between SES and schooling in the process of intergenerational mobility is presented using a schematic diagram in Figure 1.4.

Figure 1.4: Schematic diagram of the role of education in intergenerational mobility



The figure depicts mobility as a series of snapshots over time. In the first snapshot individuals are born into a particular position along the socio-economic ranking. The figure then shows snapshots throughout the trajectory of an individual's educational development and into the labour market. Specific reference is made in the figure to the ranking of achievement at the third, fourth, fifth and eighth grade and at matric as this thesis will examine achievement in these grades. Snapshot 6 ultimately feeds back into snapshot 1 reflecting the intergenerational nature of the process.

[7] The very fact that SES is at all related to educational outcomes implies that school systems undoubtedly do reproduce the social order to varying degrees, as critical reproduction theories of schooling have long emphasized (e.g. Bowles and Gintis 1976, Bernstein 1977, Bourdieu and Passeron 1977, Apple 1982). The question therefore becomes – is a particular school system likely to reduce inequality or perpetuate or even heighten it?

Chapter 2 defines SES and considers the various channels through which it might be expected to affect educational outcomes. These include the influence of SES on cognitive development prior to entering school (occurring between snapshots 1 and 2 in the figure). International and South African empirical literature examining the impact of SES on educational outcomes is also reviewed. Apart from Chapter 2, this thesis is largely an empirical contribution. Quantitative methodologies are applied to various data in order to collect evidence pertaining to the overarching question about the role of schools in South Africa's economic development. The thesis is therefore not comprehensive in its scope, but is more explorative. The main sources of information for the empirical parts are nationally representative survey data. This has the advantage that conclusions can be generalised with varying degrees of statistical confidence. This approach does not, however, represent a prejudice against other research methodologies, such as experimental or case studies, which have their own advantages.

Chapter 3 investigates reading achievement amongst primary school children in South Africa using the PIRLS 2006 dataset. The focus is chiefly on inequalities in reading achievement and the effect of SES in South Africa relative to other countries. The chapter also goes on to search for school and teacher level factors that affect student achievement after the influence of SES has been taken into account. In terms of Figure 1.4, these school and teacher characteristics affect what happens between point 2 and point 4. This motivates the search for factors that improve educational achievement and do so especially amongst low SES children.

The search for indicators of school and teacher effectiveness at the primary school level is taken up again in Chapter 4, this time with new possibilities offered by the data that was used. Several unique features of the data from the National School Effectiveness Study (NSES) used in this chapter enabled the analysis to be taken further than was possible using the PIRLS dataset. In particular, the NSES collected a rich set of school and teacher characteristics, including a teacher test and an extensive review of student workbooks, and tested the same students in grade 3 and in grade 4. Panel data (in which the exact same individuals are surveyed at more than one time) such as this, provides specific technical advantages for analysis, as is discussed in Chapter 4.

In Chapter 5 another, although very different, panel dataset is examined. Students who participated in TIMSS in 2002 as eighth graders were tracked to matric in either 2006 or 2007, depending on when they arrived there if at all. The design of the dataset therefore follows the progression in Figure 1.4, as individuals move from primary school into high school and toward the labour market. This chapter thus provides a quantitative estimate of one of the links in the figure. The analysis sheds light on some interesting trends in the ability of different parts of the South African school system to convert demonstrated ability in grade 8 into matric outcomes. The diverse trajectories of children based on early educational achievement and the type of school they are located in has important implications for future mobility, and therefore for the ability of the school system to contribute to economic development.

One of the major conclusions in Chapter 5 is that assessment practices in many of South Africa's schools are unreliable and lenient. This represents a breakdown of information or feedback in the school system. There is imperfect feedback to children about their progress (hindering effective subject choice and exam preparation), to parents about the progress of their children and the quality of schooling being received, and to the Department of Education about the effectiveness of schools and their management teams. The role of information in promoting efficient decision-making has been a key theme in the discipline of economics. This is evident in the debate between central planning and the market mechanism. Under central planning the economic authorities make production and price decisions based on systemic information. On the other hand, advocates of the market emphasise that economic information is constantly changing and that such information is decentrally possessed by individuals, who should therefore be entrusted with production and price decisions. This view is expressed in Hayek's famous 1945 essay on *The use of knowledge in society*. Drawing on agency and incentives theory, Chapter 5 closes with an application of the Principal-Agent model to South African schooling and the weak assessment practices that contribute to a lack of transparent information. Some implications for policy arise from this analysis and these are returned to in more detail in Chapter 7.

An enduring interest for economists is whether the private sector is more efficient at producing goods and services than the public sector. Milton Friedman (1955) raised the issue of private schooling into the arena of economics, proposing that vouchers be given to poor children to enable them to attend private schools. The perception may exist that independent schools in South Africa serve a rich elite and therefore may only exacerbate educational inequalities and contribute little to economic development, conceived of as raising living standards for everyone, especially the poor. Chapter 6, however, highlights some interesting differences between public and independent schools in the middle to low fee range of historically black schools. Even if it is not clear what benefits would arise from an expansion of the impendent sector, there are at least some lessons to be taken away for the school system as a whole. This chapter thus represents an additional perspective on what schools can do to promote economic development given the influence of SES.

The closing chapter summarises the main findings of this thesis, drawing together the various results about particular school and teacher level factors that are shown to be associated with student achievement. Several potentially important areas for policy and other interventions to focus on are also highlighted.

CHAPTER 2: LITERATURE EXAMINING THE EFFECTS OF SOCIO-ECONOMIC STATUS ON EDUCATIONAL OUTCOMES

It is important to understand and estimate the effects of SES on educational outcomes for at least three reasons.

In the first place, within the context of social justice a concern with equity dictates that the nature and extent of the educational disadvantage facing the poor in society be examined. Accepting that educational outcomes and labour market performance are causally linked, the extent to which educational outcomes vary with SES has strong implications for social and economic mobility over time, which are widely regarded as just and desirable social outcomes.

A second, more technical, reason for estimating the effect of student SES on educational outcomes is to improve the accuracy with which the impacts of other factors influencing educational outcomes can be measured so that appropriate policy measures can be attempted, where feasible. Numerous home, teacher and school characteristics are correlated with SES or operate differentially depending on student SES. For example, in South Africa classes tend to be larger in schools serving poor communities where the level of educational performance is also lower in general. In order to estimate the influence of class size correctly it is therefore necessary first to "control for" the effect of SES. Put differently, one should estimate the effect of class size conditional upon SES.

Thirdly, it is important to understand how specific teaching and school characteristics might interact with the relationship between SES and educational achievement. It would be most desirable from an equity perspective to identify factors that can be influenced by policy and that positively impact on educational achievement and do so especially in the case of poor students.

This chapter starts by discussing the meaning of SES and how this concept has been treated in the literature over time. Thereafter, it discusses the various channels through which SES might be expected to influence educational outcomes. The so-called "education production function" literature is then considered with a focus on the estimated effects of the impact of SES emerging from this literature. International and then South African studies are discussed. Thereafter, several studies using Hierarchical Linear Modelling (HLM) are reviewed as this methodology is particularly apt for describing how the relationship between SES and educational achievement can differ depending on other characteristics. Finally, literature that draws conclusions about social and economic mobility based on the influence of SES on educational outcomes is discussed.

2.1) Defining socio-economic status

A useful definition of SES is the "relative position of a family or individual on an hierarchical social structure, based on their access to, or control over, wealth, prestige, and power" (Willms, 2004: 7, quoting Mueller and Parcel, 1981). In economics, where the intention is often measurement, SES tends to be conceived of in terms of its proxies, such as income, education or occupation. In sociology, which is where the concept emanates from, SES encompasses societal rank, prestige and position (Bullock and Stallybrass, 1982: 599). Consequently, as Bradley and Corwyn (2002) maintain, there has been a tug of war between conceptions of SES that emphasize economic position and those that emphasize social prestige. Psychologists have often framed SES using the notion of capital. According to Bradley and Corwyn (2002: 372), this is because financial capital (material wealth and income), human capital (educational and skills resources) and social capital (social connections) all closely affect well-being and often overlap.

When studying societies with substantial material deprivation it is perhaps justifiable and more useful to concentrate on SES in terms of material well-being and economic position rather than prestige or social class. This, together with the objective of measurement, motivates the approach to SES taken in this thesis.

Stemming from the various definitional components of SES, educational research has tended to operationalise SES using three main proxies: parent income, parent education and parent occupation. As Sirin (2005) points out, research published in the 1950's and 1960's usually worked with some categorisation of parent occupation as a proxy for SES. Measures of parent occupation, such as Duncan's Socioeconomic Index of 1961, are suitable because while they are usually correlated with parent education and income they also reflect social prestige and influence. Parent income is a means to other material and social resources and is therefore a good indicator of SES. Similarly, parent education is a valuable indicator because it is typically established early on and remains fairly constant throughout a child's education. Moreover, parent education and parent income are highly correlated in most societies. Recent research has increasingly used parent income and parent education as well as other indicators such as family structure or household assets as measures of SES. Due to various practical difficulties involved in the measurement of parent income and education in large-scale sample surveys, the use of asset-based indices of household wealth can be regarded as an attractive alternative for the measurement of SES. This point will be argued more extensively in Chapter 3.

2.2) Channels through which socio-economic status affects educational outcomes

Disentangling the processes through which SES affects educational outcomes is fraught with difficulty because there are so many interconnected dynamics associated with SES that are educationally disadvantageous. Poverty itself is a multidimensional concept that goes beyond merely income or material aspects, but is bound up in social and economic systems, ideology, relationships and the ability to function as fully human, as emphasised in more nuanced conceptions of poverty such as Sen's "capabilities" approach. It would therefore be simplistic to view the processes through which SES interacts with education as separate or linear channels of causality. Nevertheless, this section will discuss several of these processes, while recognising that many of them overlap, interact and reinforce each other.

Historically, education has both defined class and been defined by class. For centuries it was reserved for the nobility, clergy and upper classes. At times this was because only the wealthy and powerful had the material means to forgo labour in favour of education. At times it was the powerful that denied the powerless an opportunity to be educated, often justifying this with ideology regarding beliefs about a fixed order in society and the appropriateness of education for those with different "rightful" places in society. This idea was prevalent in Plato's ideal society, where different education would be given to those with different ranks and roles. Given the historical connections between class and education, it is unsurprising that SES and education have remained closely linked ever since the spread of mass education with the industrial revolution and to the present day.

A first channel or category of channels through which SES affects educational outcomes is the material resources to which children have access. A major way in which material resources affect child development is through nutrition. It is well documented that the incidence of poverty is higher amongst children than adults in South Africa (World Bank/Rdp Office, 1995). Fleisch (2008) describes how malnutrition and numerous other child health problems are strongly linked to poverty in South Africa. In support of his analysis, Fleisch (2008: 33) reviews several studies that have examined child health and educational performance. One study found that more than 40% of those in the poorest decile of South African children suffered from stunted growth (Zere and McIntyre, 2003). The link to education is demonstrated by international research, which has shown that stunting during the first two years of life is associated with weaker cognitive performance at school age (Sibanda-Mulder, 2003 – quoted in Fleisch, 2008: 33). Poverty thus hinders cognitive development via nutritional deficiency from a very early age and even prior to birth. For example, foetal alcohol syndrome causes lasting developmental impairment and is a widespread phenomenon in many of South Africa's poorer communities. Moreover, the experience of hunger while at school diminishes a child's ability to concentrate and learn. Although the National School Feeding Programme has been implemented, nutrition remains a key channel through which poverty affects educational outcomes in South Africa.

Child labour, mainly in the form of household chores, is a common occurrence throughout much of South Africa, especially in rural areas. This is usually necessitated by a lack of resources or by the distance required to travel on foot in order to secure vital resources, such as water and wood. According to the 1999 Study of Activities of Young People (SAYP), African girls between 10 and 14 years of age spent 75 minutes per day on cooking and food preparation and an hour per day cleaning the house on average (quoted in Fleisch, 2008: 70). Such labour is likely to obstruct education in various ways. It distracts children from doing homework or other educational activities outside of school. It may leave children tired out and less able to concentrate by the time they are at school. Moreover, household responsibilities may occasionally or frequently prevent children from attending school.

The availability and quality of educational resources at home also varies widely with SES. One such resource, which is often a good indicator of the level of educational support at home, is the number of books at home. Other stationary, computers, access to internet and even electricity itself are important educational resources that are often absent in the homes of low SES children. The overall physical living conditions of a child's home, including warmth, space, cleanliness and water facilities, combine to create an environment that is either conducive to learning or not.

A second and related channel through which SES affects educational outcomes is the availability and quality of educational support in the home. Bearing in mind that parent education is often taken as a proxy for SES, it follows that more affluent parents are more motivated and able to engage in educational activities with their children than are less affluent parents. James Heckman (2006: 1900) argues that "disadvantage arises more from lack of cognitive and noncognitive stimulation given to young children than simply from the lack of financial resources". In addition, more affluent parents have superior access to information that will contribute to their children's health, social and emotional well-being, all of which feed into educational development.

These processes begin during the crucial years of early childhood development. The literature on child development underlines the early relationship with parents or primary care givers as the most crucial and formative relationship in a child's development. This relationship is embedded in contexts – those of peers, parents' marital situation, neighbourhood, etc. Many of these contexts are unfavourable in poor families, and therefore impede the parent-child relationship and hence child development. According to Shonkoff and Phillips (2000: 230), research highlights two fundamental needs that are addressed within a child's earliest and closest relationships. These are the confidence with which to encounter new situations and people, and a sense of their own competence and efficacy. These attributes contribute strongly to the aptitude of a child to learn.

A large body of research has investigated how particular parenting methods and styles are associated with performance on tests of cognitive ability. The sensitivity and appropriateness of parent responses to child cues is one factor that has consistently been associated with higher test scores. Parent expectation regarding learning has also been shown to affect child development substantially. Shonkoff and Phillips (2000: 246) point out that the precise nature of these factors differs across cultures and amongst sub-groups (e.g. boys and girls) within cultures. For example, certain cultures value numerical ability above language and this affects learning via the expectations parents have and the ways they reward their children from an early age. In South Africa many parents, especially amongst the rural poor, are illiterate, and are therefore unlikely to strongly encourage and reward numerical or language related early learning.

Numerous studies in the literature on child development have investigated how cognitive ability and learning are dependent on the home environment, by using the "HOME"[8] inventory, following the studies of Caldwell, Bradley and Elargo, amongst others, in the late 1970's and 1980's. Bradley and Caldwell (1984), for example, demonstrated that IQ test scores at age two were strongly associated with "maternal responsivity" and the quality of language stimulation available, while test scores in the first grade were most strongly associated with the "play materials" item on the HOME inventory.

All these processes contribute to what Lee and Burkham (2002) call "Inequality at the Starting Gate". They present evidence of significant disparities in the cognitive ability of children from poor relative to affluent families upon entering school. These initial disparities are likely to be compounded as children proceed through school and differential home support continues to augment or hamper educational achievement, for example through help with homework and through the value given to education in the home. The extent to which initial educational disparities on the basis of SES persist depends on the nature of the school system in a society, as research by Heckman (2006) and Feinstein (2003) demonstrates. Their research will be discussed later in this chapter in the section on mobility.

A third mechanism by which SES affects educational achievement is the ability of parents to ensure that their children are placed in good quality schools. In many countries high SES parents indirectly choose school quality through their residential choices (Hanushek, Kain and Rivkin, 1998: 32). This is especially true of South Africa. Historically, residential choice for non-white South Africans was severely restricted by the Group Areas Act (1950) and forced removals under apartheid. Schools too were segregated by race. Although schools are no longer officially segregated, the residential patterns established under apartheid have to a large degree persisted, thus effectively limiting school choice. More affluent parents also have the resources to send their children further away to what they perceive as better schools and to pay higher school fees. In contrast, those who are "trapped" in a poor neighbourhood may face a concatenation of factors hindering educational achievement. Not least of these factors is that schools in such areas tend to be under-resourced and of a generally poor quality.

[8] Home Observation for Measurement of the Environment.

Peer effects are an important part of how SES affects educational outcomes through the channel of school choice. The importance of peers was one of the most significant features of the Coleman Report of 1966. James Coleman was commissioned to investigate inequalities in educational opportunity in America. It was assumed that the major differential would be race. Several unexpected findings emerged in the study. The disparity between spending on black and white children was found to be less than expected. Secondly, funding did not appear to be a particularly good predictor of educational achievement. Instead, the home background and SES of students was strongly associated with achievement. Thirdly, there was evidence of strong peer effects on learning achievement – specifically, the socioeconomic background of peers had a large effect.

The Coleman Report espoused the idea that the socioeconomic mix of the student body is an important school resource, perhaps more important than funding (Kahlenberg, 2001). When the socioeconomic mix of students in a school is concentrated at the low end a multitude of problems are common, such as disruptive and anti-school attitudes, a lack of discipline and phlegmatic attitudes towards attendance. A further reason for the advantage associated with having affluent peers is that parents may be able to influence school quality through their involvement in school affairs and the expectations they place on school management and teachers. Parents of higher SES are generally better able and more motivated to be involved in these ways. Thus, over and above within-school peer effects, the socioeconomic mix of the school has a further effect on individual educational outcomes through parent involvement.

Furthermore, within each school more high profile parents, who may be distinguished as such on the basis of SES, tend to have more influence on school proceedings and their children may receive favourable treatment. Parent involvement in school affairs can therefore be construed as another mechanism through which SES affects educational achievement.

A final channel to be discussed here that has some overlap with the issues surrounding school quality is that of neighbourhood effects. As contagion theories of poverty highlight, when there is a high concentration of poverty in a community many of the problems that are associated with poverty tend to spread throughout the community, much like a contagious disease. Such problems include unsafe streets, a lack of economic opportunities, a high incidence of non-traditional family structures, the absence of positive role models, a general attitude of hopelessness and low self-efficacy. Curley (2005: 103) explains that "contagion" and "concentration" theories emphasize how the lack of social capital (social connections and supports that arise from them) perpetuates poverty in a community. These factors and the exposure to street norms lead to low self-expectations. William Julius Wilson's influential theory of urban poverty in *The Truly Disadvantaged* espoused the notion of "concentration effects", according to which concentrated poverty in a neighbourhood affects individual outcomes, irrespective of family characteristics (Curley, 2005). A study by Duncan (1994) found that the affluence of an individual's neighbour had a significant effect on ultimate educational attainment, even after controlling for family characteristics such as parent income and education.

In summary, there are numerous channels through which SES can be expected to influence educational outcomes, although a clean decomposition or separation of these channels would be near impossible due to the complex interconnectedness amongst them and structural aspects of poverty. In South Africa such a separation is even harder because of the historical overlap between class and race. Generations of institutionalised inequality have ensured that the "hierarchical social structure" of SES was constructed to be on the basis of race. Patterns of wealth and poverty continue to have strong racial dimensions. Although in recent years a black middle class has begun to emerge, the vast majority of South Africa's poor are black. Characteristics that are associated with SES therefore tend to be associated with race. For example, non-traditional family structures such as "skip-generation" households, which are common within low SES groups and have been shown to negatively affect educational outcomes negatively, are most prevalent among black households in South Africa (Anderson, 2000).

Another factor through which the effect of SES is mediated in South Africa is language. The national matriculation results together with many other evaluations of achievement in South Africa consistently show that Afrikaans and English first language speakers perform significantly better than African language speakers. Sarah Howie (2002), for example, demonstrated that proficiency in English is a strong predictor of mathematics achievement amongst South African students. As Taylor *et al* (2003: 54) explain, there are two main reasons for this language effect. Firstly, to some extent language is capturing the effect of race and SES. Secondly, the language of instruction in African schools after the first three years of schooling is English. Therefore, African language students face the disadvantage of having to learn in a language that is not their first language. Attempting to disentangle class from race and language in South Africa is thorny, and this is a dynamic that adds complexity to the analysis in this thesis.

2.3) The effects of home background and school characteristics on educational outcomes

Studies analysing the effect of SES on education tend to examine one of two outcome variables: attainment (measured in years of education) or achievement (measured by test scores). The influence of home SES on educational attainment operates very differently in developed countries to the case in developing countries. Analysing longitudinal data for the USA, Belley and Lochner (2008) consider how the effects of family income and ability on years of post-secondary education have changed since the early 1980's. They find that family income had a much greater effect on post-secondary attainment for students graduating in the early 2000's than it did for those graduating in the early 1980's. They suggest that three broad trends have contributed to this change: increasing returns to skill on the labour market, rising costs of tuition and greater borrowing constraints facing students. The first of these trends represents a greater incentive to invest in post-secondary education while the second and third mean that family income is a more important factor in determining access to post-secondary education. Of course this study, and others like it, is indicative of the sort of effects that family income or SES has on education in developed countries. However, the effect of family background operates at a very different level in developing countries.

Filmer and Pritchett (1999) have presented a rich analysis of wealth gaps in educational attainment in developing countries. They apply two definitions of a wealth gap in their investigation. Firstly, they define it as the difference between the proportions in the richest and the poorest groups that have completed a particular grade. Secondly, they define it as the difference between the median educational attainment of each group (Filmer and Pritchett, 1999). Their purpose was to investigate how countries were doing in the quest to achieve universal basic, or even secondary, education, as many countries have explicitly targeted. Using the first definition, Filmer and Pritchett (1999) showed that in some countries only the poor had not yet achieved universal primary education, while in other countries much of the middle class also did not yet enjoy universal primary education. There were only a few countries in their analysis in which the rich had not yet achieved universal primary education. Median attainment amongst poor 15-19 year olds in much of central and Western Africa was zero as most of these individuals did not even complete a single year of schooling. Attainment amongst the rich in these countries was not very high either with the result that the wealth gaps reported by Filmer and Pritchett (1999) ranged from only four to six years. South Asia recorded the largest wealth gaps with the poor hardly attending school and the rich achieving high levels of attainment. The wealth gap was largest of all countries in India (ten years), closely followed by Pakistan (nine years) and Bangladesh (six years).

White (1982) conducted an extensive review of nearly 200 studies in which the relationship between educational achievement and SES was examined. The measures of SES were almost always parent income, education or occupation, or a combination thereof. White (1982) found that amongst studies in which the unit of analysis was individuals, as was most common, SES was consistently but weakly associated with achievement, the average correlation being 0.22. Moreover, in these studies SES typically accounted for less than 5% of the variance in achievement. When the unit of analysis was aggregated the correlation tended to be higher, averaging at 0.73 (White, 1982: 461). More recently, Buchmann (2000) has replicated White's meta-analysis considering studies during the 1980's and 1990's. All 38 studies in Buchmann's review that focussed on attainment as the outcome of interest found SES to be a significant predictor. Similarly, she listed 22 studies where achievement was the outcome of interest, all of which found SES to be significantly associated with achievement. Some of these included household possessions in the measure of SES, although parental education and occupation remained the most common measures.

2.3.1) The debate about whether schools make a difference

A major debate exists in the literature regarding how deterministic SES is for educational outcomes, and conversely, how much of an impact can be expected from school effects. It was the Coleman Report (1966) that sparked this debate. As discussed earlier, Coleman *et al* (1966) argued that the home background of students, and especially that of their peers, was the overwhelming influence on educational outcomes, rendering schools somewhat impotent in regard to raising outcomes for poor students. The following paragraph from the Coleman Report captures this argument well.

> "Taking all of these results together, one implication stands above all: that schools bring little influence to bear on a child's achievement that is independent of his background and general social context; and that this very lack of an independent effect means that the inequalities imposed on children by their home, neighborhood, and peer environment are carried along to become the inequalities with which they confront adult life at the end of school," (Coleman *et al*, 1966: 325).

This conclusion was disturbing to educators and educational researchers and it led to a renewed determination to discover significant school effects. Edmonds (1979) describes how a number of studies done in the USA during the 1970's set out to show that schools could indeed make an important contribution to learning for poor students. Several distinctive features of schools that were successful at educating poor students emerged from these studies. These included strong leadership, a climate of expectation with respect to student performance, an orderly school environment and frequent monitoring of student progress (Edmonds, 1979).

A major contribution to the debate was made by Heyneman and Loxley (1983), who contended that the "Coleman Report conclusion" about the weakness of school effects was a generalisation based on only a few of the world's education systems, namely those in North America, Europe and Japan. They investigated the relative impacts of "pre-school influences" and school quality on academic achievement in Asia, Latin America, Africa and the Middle East. Heyneman and Loxley set forth a case that in low income countries student SES accounted for less of the variation in achievement than it did in high income countries. Furthermore, they found that the effect of school quality was greater in low income countries than in high income countries. They therefore argued that when considering a more representative sample of students from around the world it is clear that the predominant influence on academic achievement is school quality (Heyneman and Loxley, 1983: 1162). This finding of weak school effects in high income countries and stronger school effects in low income countries was very influential and became known as the Heyneman-Loxley effect in the literature.

Fuller and Clark (1994) conducted a review of about 100 school effectiveness studies on developing countries. In line with the so-called "Heyneman-Loxley effect", Fuller and Clark (1994) concluded that large and consistent school effects were present in three broad areas: the availability and use of textbooks and learning materials, teacher knowledge and verbal proficiency, and the instructional time and level of work demanded of students. Fuller and Clark (1994: 135) suggest that the larger recorded school effects in developing countries than in developed countries may be at least partly due to a low initial baseline of inputs. Thus, as the effectiveness of schools increases, the marginal return to additional inputs declines.

Eric Hanushek (1995) reviewed 96 studies which used education production function techniques to estimate the effects of various school resources. The results are reproduced in Table 2.1. Consistent with the "Heyneman-Loxley effect", the estimated effects were larger for developing countries. Scheerens (2000: 59), commenting on Hanushek's (1995) review, attributes the stronger association between outcomes and resources in developing countries to the greater variance in the independent and dependent variables in developing countries than in industrialised countries.

Table 2.1: Percentage of studies that found significant positive associations with various school inputs according to Hanushek's (1995) review

Input	**Industrialised Countries** (% Significant positive associations)	**Developing Countries** (% Significant positive associations)
Teacher-pupil ratio	15%	27%
Teacher Education	9%	55%
Teacher Experience	29%	35%
Teacher Salary	20%	30%
Per-pupil Expenditure	27%	50%

Source: Hanushek (1995, 1997 – quoted in Scheerens, 2000: 59)

In another review of the school effectiveness literature, Scheerens (2001: 361) estimates that approximately 15% of the overall variance in student achievement in industrialised countries can be attributed to between-school differences, after adjusting for student background characteristics. For developing countries this figure is approximately 30%. For Scheerens (2001), this proportion is large and therefore promising regarding the potential for school improvement to influence educational achievement.

More recently the empirical validity of the "Heyneman-Loxley effect" has been challenged. Baker, Goesling and Letendre (2002) examined data from TIMSS 1994 and found that a greater proportion of variance in academic achievement was explained by student factors than by school quality effects. They argue that the "Heyneman-Loxley effect" is vanishing due to a strengthening of the link between family SES and the quality of schools that students attend. Although this trend is well established within developed countries, it is also increasingly prevalent in developing countries with the spread of basic education, according to Baker *et al* (2002: 311).

On balance, enough studies have found that schools can make a difference to suggest that the pessimistic conclusions of the Coleman Report about the impotence of schools to reverse or reduce student inequalities were too strong. The ability of schools to improve outcomes for low SES children undoubtedly varies across countries. The extent to which South African schools in poor communities are able to raise outcomes is one of the central questions in this thesis.

2.3.2) Education Production Function studies in Latin America, East Asia and Africa

The majority of studies in the vast education production function literature have been done for developed countries, especially the USA. Several studies are reviewed here to give a flavour of the research that has come out of other parts of the world. Wilmss and Somers (2001) use HLM[9] to investigate the effects of student family background as well as school-level variables in 13 Latin American countries on three schooling outcomes: language achievement, mathematics achievement and grade progression. They demonstrate that the effect of SES varies across the countries, from fairly strong effects to more equalised outcomes in the top-performing country, Cuba. Despite the influence of family background, several school effects were found to be significant. Low pupil-teacher ratios, well trained teachers, well stocked libraries and more instructional materials were the school resources that emerged as important in the study. Classrooms where students were grouped according to ability or which were multigrade had negative effects. Frequent testing, high levels of parent involvement and a positive learning environment with good discipline were other positive school effects that came through (Wilmss and Somers, 2001: 438-9).

Ludger Woessman (2003) analysed the effects of home background and school effects in five high performing East-Asian countries. Although the five countries all performed exceptionally well in student achievement evaluations such as TIMSS, Woessman (2003) demonstrates that

[9] The HLM methodology is explained in Chapter 3.

there was a significant degree of heterogeneity in the way that family background characteristics influenced achievement in these countries. For example, student SES had a much larger impact on achievement in Korea and Singapore than it did in Hong Kong and Thailand. Moreover, Woessman (2003) found that countries that allowed high SES to favourably affect student achievement enjoyed higher overall levels of performance. Conversely, Woessman (2003: 29-30) suggests that countries wishing to equalise performance may only be able to do so at the expense of the overall level of performance.[10]

Woessman (2003) found that variations in class size in Japan and Singapore did not have any causal effect on student achievement. The data for the other three countries did not permit a meaningful evaluation of the effect of class size. Woessman (2003) also investigated the extent to which the high level of achievement in these East Asian countries could be attributed to various institutional features. In Japan and Singapore students in schools that had the autonomy to set teacher salaries performed better than students in schools that did not (Woessman, 2003: 28). A favourable effect of the amount of homework assigned was found in certain countries and subjects, although Woessman (2003: 28) cautions that this may have been partly due to endogeneity and omitted-variable bias. Lastly, the level of parental interest and involvement in school affairs emerged as a third institutional feature having a positive impact on student achievement.

Lee, Zuze and Ross (2005) applied multilevel modelling to 14 African countries using the SACMEQ II dataset. They computed a composite index for social background using questions to students about their parent's education, the type of dwelling they lived in and the presence of a number of household possessions. The authors found strong links between social background and reading achievement in all of the countries in the sample. Moreover, in eight of the 14 countries the average social background of schools had a significant impact on student reading achievement. The authors reported several important school effects, after controlling for social background and school composition. Flowing from these school effects, Lee *et al* (2005) offer a number of policy suggestions: the enrolment size of schools should be smaller; the practice of

[10] This argument by Woessman (2003) may appear to contradict the observable pattern that most of the top-performing countries in surveys such as TIMSS and PIRLS are also relatively equitable in terms of educational achievement. The appropriate application of Woessman's point is that in countries, such as South Africa, with a large proportion of poor children in schools that are performing at low levels an action to reduce the positive effect of high SES for those top-performing students would probably lower the overall achievement of the system.

"shifts" should be avoided; physical and human resources should be increased in poor schools; and grade repetition should be avoided where feasible.

2.3.3) Education production function studies in South Africa

Anderson, Case and Lam (2001) investigated the effects of family structure on educational outcomes in South Africa. Family structure might well be considered a proxy for SES. Anderson *et al* (2001) observed that only 55% of black and coloured 12 year olds lived with both their parents, and that this figure declined to 50% for 17 year olds. They found that children living with both parents achieved the best outcomes on three measures: the enrolment rate, the number of grades completed and educational delays (the difference between the number of grades completed and the number of years in school). Children living without any parents at home achieved the worst outcomes, while intermediate outcomes were achieved by those living with a single mother.

Van der Berg and Burger (2002) used the level of school fees as a proxy for the SES of the parent body of schools in their investigation of the outcomes of schooling in the Western Cape. They found that performance differed between schools of varying SES and racial composition, although the resource allocation variables included in the model were not significantly associated with school performance. These resource variables included the pupil-teacher ratio, the quantity of teachers, an index of physical resources and various measures of teacher quality. Van der Berg and Burger (2002) found that about two-thirds of the variation in school performance was explained by SES, racial composition and the teacher resource variables. They suggest that two categories of omitted variables may account for much of the unexplained variation: the level of basic teaching and learning support materials and the efficiency of school management. This suggestion is in line with the findings of Crouch and Mabogoane (1998), who also point to management efficiency as a potentially important omitted variable from their analysis.

Crouch and Mabogoane (1998) concluded that family income was strongly associated with school performance in the North West and Gauteng provinces. Moreover, they found that a dummy for the school having formerly been under the administration of the Department of Education and Training (DET) was negatively associated with performance. They felt that this dummy was to some extent acting as a proxy for the quality of school management. Moreover, Crouch and Mabogoane proposed that the residual (accounting for between 20% and 30% of the variation in school performance) also contained the effects of differential management efficiency. Therefore, they estimated that approximately 50% of the variation in school performance was attributable to the unobserved feature of management efficiency.

Bhorat and Oosthuizen (2006) estimated an education production function for matric results. They found that certain types of school infrastructure made a significant difference to performance. These included classrooms, school libraries and computer facilities. As with Crouch and Mabogoane (1998), Bhorat and Oosthuizen (2006) found that the former department of education was an important predictor of performance. They also found that various proxies for teacher quality were significantly associated with performance.

Martin Gustafsson (2007) estimated education production functions using the SACMEQ II dataset. An important aspect of this study was a comparison of results using Ordinary Least Squares (OLS) regression with those obtained using HLM.[11] Gustafsson (2007) established that physical infrastructure, textbooks and budgets for nutrition were important resources affecting achievement. Classroom practices that were positively associated with achievement included less student repetition and a suitable allocation of time between teaching and management. An interesting methodological aspect of Gustafsson's study was the decision to analyse a sub-set of historically disadvantaged schools separately from the entire South African sample. This was done in recognition of the observation that there are effectively two historically different and persistently differently performing parts of the South African school system, and factors affecting achievement may operate differently within each system. The analysis of the historically disadvantaged set of schools rendered certain effects insignificant that had come through significantly in the models for the full sample, and highlighted other effects that were not evident in the full sample models. For example, an additional year of pre-service training for teachers was associated with better student achievement in the full sample models but not when the historically disadvantaged schools were modelled separately (Gustafsson, 2007: 94).

Another study also analysing the SACMEQ II dataset that made use of a similar division of the South African school system was done by Van der Berg (2008). This study found that a

[11] The results of education production functions using OLS and HLM are also compared in this thesis in Chapters 3 and 4.

significant performance advantage was enjoyed by students who lived with their parents, thus confirming the findings of Anderson *et al* (2001), who had found the same in the case of educational attainment. Van der Berg (2008: 14) also demonstrated that the effect of SES was non-linear: the impact of SES on achievement was greater at higher levels of SES. An important contribution of this study is the understanding that school resources do matter in South African schools, but only conditionally upon other factors. Van der Berg (2008: 153) argues that school resources do not necessarily make a difference but that the ability of schools to convert resources into outcomes is the crucial factor, and that this is where policy attention is required. This view of the impact of resources differs somewhat from the findings of an earlier and influential study by Case and Deaton (1999), who found a significant effect of pupil-teacher ratios on educational outcomes on South Africa. Although this study was influential it was based on 1993 data, and its findings have been questioned (for example by Crouch and Mabogoane, 1998) and have not been consistently confirmed by other studies.

One could summarise the main findings emerging from South African studies as follows: Family SES underlies a great deal of the variation in educational outcomes in South Africa. Once SES has been controlled for, additional school resources do not necessarily have a significant impact on outcomes as this link is conditional upon how effectively resources are used. Management efficiency is hard to observe but probably accounts for a lot of the variation in South Africa's educational outcomes.

2.4) Factors affecting the relationship between SES and educational achievement

Practitioners of HLM, sometimes called multilevel modelling, frequently argue that HLM is more appropriate than OLS regression when analysing educational data that has a "nested" structure (students are nested within classrooms). HLM, however, offers a further advantage in that it allows one to model how the relationship between a student characteristic and an educational outcome differs across schools. For example, HLM has the potential to identify school factors that reduce the impact of SES on achievement. As Lockheed and Longford (1989: 6) explain, "hierarchical analysis allows a major shift in how the effects of organizations on individuals may be viewed: instead of considering only the effects of organizational characteristics on organizational means, the effects on relationships are also modeled."

2.4.1) International studies

Applying a hierarchical linear model to Canadian data, Willms (1997) found that SES influenced literacy achievement differentially on the basis of the level of socio-economic integration within schools. Willms found that in areas where there was a greater degree of socio-economic integration within schools, the gap between high and low SES children was smaller.

Zuze (2008) estimated a multilevel model for Uganda and found that improvements in the physical resources of schools served to reduce the disadvantage facing poor students. Although it would be unjustified to interpret a result such as this as universally applicable, this finding is indicative of the significance that analyses of the effects of SES on educational achievement, particularly through multilevel modelling, can have.

Elsewhere, Zuze (2010) estimated two HLMs for Botswana using separate datasets: TIMSS 2002 and SACMEQ II. Using the SACMEQ data, she found that more frequent testing was linked to better performance and to smaller gaps between high and low SES students. Although the merit of frequent testing is a contested issue, on the face of it this finding represents a potential way to improve both equity and the overall level of achievement in Botswana's schools. Using TIMSS, Zuze (2010) found that students benefited from teachers with higher levels of education but that rich students gained more from this than poor students. Although teacher education pronounces the effect of SES on achievement in this way, it would hardly be advisable to reduce the level of teacher education in order to achieve greater equity as this would mean a lower level of achievement for all students. The significance of this finding for policy is perhaps rather that raising the level of education amongst teachers can be expected to lead to higher overall student achievement, but the gains will be least for poor students. Therefore, conditional upon cost considerations, policy makers may prefer other means of raising educational achievement so as to promote equity at the same time.

The study of school effectiveness in 14 African countries by Lee *et al* (2005) has already been reviewed, and as was mentioned found strong links between social background and reading achievement. Although this study did use HLM, the authors chose not to explore factors that might reduce or enlarge the effect of social background on achievement. An opportunity for further research is, therefore, to investigate what factors interact with SES to influence educational achievement in African countries using the SACMEQ surveys.

2.4.2) South African studies

Gustafsson (2007), in his paper comparing HLM with OLS models for South Africa, chose not to focus on factors that influence the relationship between SES and educational achievement. Armstrong (2009), on the other hand, set about an HLM analysis using TIMSS 2002 with the explicit intention of discovering school characteristics that reduced the impact of SES on achievement. Despite her deliberate approach, Armstrong could not identify any such factors, although she did establish a strong effect of SES on achievement, as one would expect from South African educational data.

Van der Berg's (2008) HLM model for South Africa based on the SACMEQ II data showed that the relationship between student SES and achievement was stronger in schools with higher mean SES. Van der Berg (2008: 152-153) considers various possible interpretations of this result. Mean SES may simply have been acting as a proxy for other influential factors, such as peer effects, resources or urban residence. Ultimately, Van der Berg (2008) concludes that it was probably a proxy for all these factors combined. One might add to his conclusions that school mean SES was probably also reflecting differences in management efficiency – that it was capturing some of the so-called "management residual" proposed by Crouch and Mabogoane (1998). As Van der Berg (2008: 153) himself puts it, there is a "large divergence in the ability of schools to convert resources into outcomes."

Nevertheless, the finding that at higher levels of school mean SES the impact of student SES was greater is important, and links to Zuze's (2010) result that the gains from teacher quality are greatest for high SES students. This also concurs with Woessman's (2003) suggestion that achieving greater equity in educational achievement might often not be compatible with raising the overall level of achievement. To the extent that a conflict between the objectives of equity and the overall level of achievement emerges, this area of research takes on a moral dimension. According to the principles of justice proposed by John Rawls (1971), for example, inequity in outcomes is no problem if it leads to an absolute improvement in the achievement of the worst-off. Yet, the search for factors that might reduce the impact of SES on achievement in South Africa is still very much open.

2.5) The impact of SES on education: Implications for mobility

Given that SES does impact on educational outcomes and that educational outcomes are strongly linked to labour market success in most societies, it is clear that the strength of the relationship between SES and education bears importantly on intergenerational mobility. One can think of intergenerational mobility as the extent to which movements along the socio-economic spectrum occur from one generation to the next in a particular society. There are various ways of measuring intergenerational mobility. Simply though, the stronger the association between the incomes of one generation and the next, the weaker intergenerational mobility is. Mobility, as this measure implies, necessarily involves some climbing up the ranking at the expense of others slipping down the ranking. A mere churning is not necessarily a desirable social outcome. What is more important is that the overall level of development advances over time, and that this improves the life chances of the poor. It is with this caveat in mind that mobility is considered in this thesis.

Blanden, Gregg and Macmillan (2007: 43) maintain that education is the most obvious transmission mechanism through which the income of one generation affects that of the next. Yet there are multiple and interconnected channels, including education, through which intergenerational transmission of capital occurs. Several economists have offered formalised models of this process. Becker and Tomes (1979: 1158) propose that "children are assumed to receive endowments of capital that are determined by the reputation and 'connections' of their families, the contribution to the ability, race, and other characteristics of children from the genetic constitutions of their families, and the learning, skills, goals, and other 'family commodities' acquired through belonging to a particular family culture."

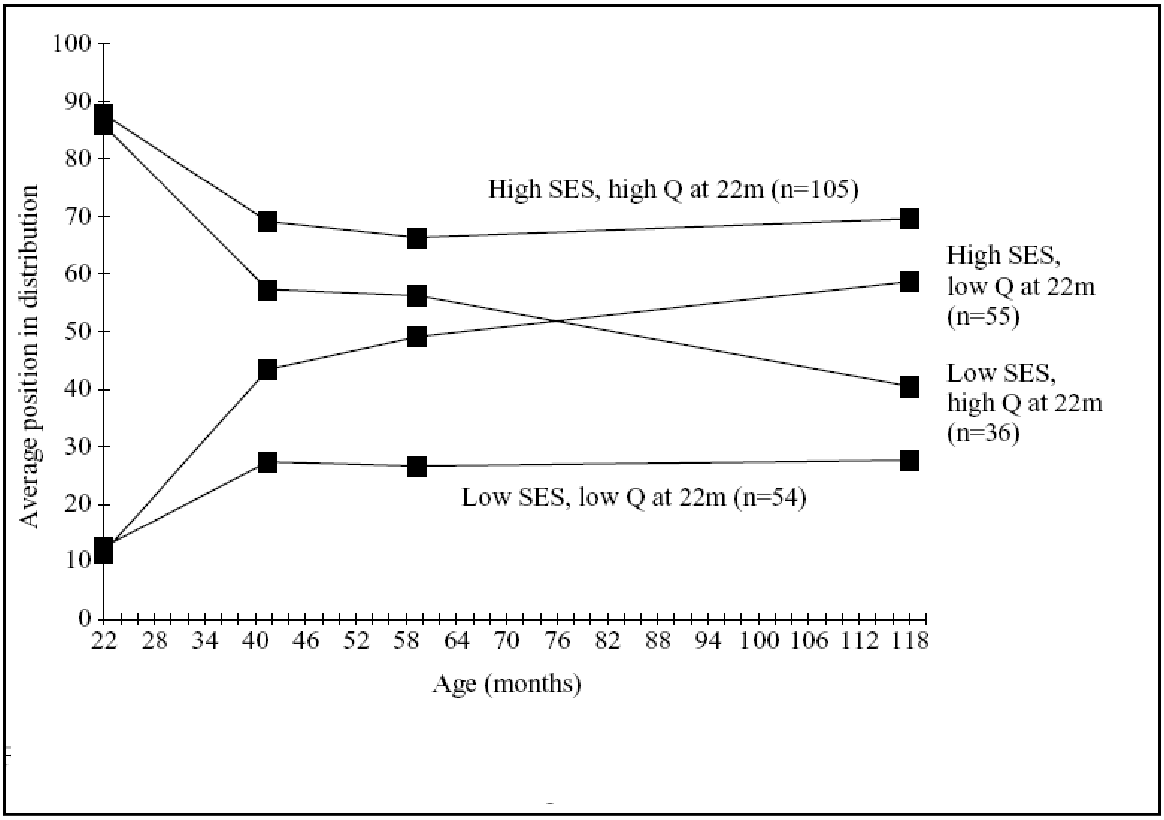
Blanden *et al* (2007) estimate intergenerational income persistence (or immobility) in Britain by modelling the earnings of sons on the average of their family income at the ages of 10 and 16. They report a coefficient of 0.32. They then attempt to explain this coefficient by various proposed transmission mechanisms. To qualify as a relevant transmission mechanism a variable should be related to both past family income and to labour market earnings. Blanden *et al* (2007) thus account for the coefficient on family income in predicting son's earnings (0.32) on the basis of non-cognitive skills, cognitive skills, education and labour market attachment (experiences of unemployment). They found that non-cognitive skills and cognitive skills accounted for 6% and 7% of the intergenerational mobility coefficient. Education was found to explain just over 31% of intergenerational persistence. Lastly, labour market attachment explained approximately 9% of the association. Together, these factors accounted for about 54% of the intergenerational persistence coefficient of 0.32, leaving an unexplained component of 46%. The large contribution of education to intergenerational income persistence provides strong grounds for investigating issues of equity in educational outcomes.

A framework for considering the role of education in the process of intergenerational mobility was provided by the schematic diagram in Chapter 1 (Figure 1.4). This diagram illustrated that the SES into which children are born, feeds into their cognitive ability at the start of formal schooling, and that its effects can still be traced throughout the trajectory of schooling, into the labour market and ultimately to the next generation.

There is substantial evidence to account for the links between the various stages depicted in the schematic diagram. Numerous studies have demonstrated that powerful effects of family SES on the cognitive development of children are observable very early on in life. Feinstein (2003) has shown that even by the age of 22 months there are considerable differences between the cognitive abilities of high and low SES children. Feinstein (2003) examined the trajectories of these children using panel data with test scores at age 22 months, 42 months, 60 months and 120 months, and their ultimate educational attainment at age 26. He established that the test scores at 22 months were correlated with educational attainment at age 26, although the correlation of attainment with scores at 42 months was stronger. Feinstein (2003) observed a considerable amount of upward mobility for high SES children that achieved low scores at 22 months, especially during the phase between 22 and 42 months of age. High SES children that scored poorly at 42 months achieved only small improvements in their ranking after that. Amongst low SES children, those with low initial scores tended to remain near the bottom end of the rankings at later stages while those with high initial scores were prone to slipping down the ranking, especially during the phase between 22 and 42 months.

Figure 2.1 is borrowed from Feinstein's (2003) study and shows the average rank position in the distribution of children in the sample at ages 22, 42, 60 and 120 months. Four groups are tracked in the figure: high SES children with high initial scores, high SES children with low initial scores, low SES children with high initial scores and low SES children with low initial scores.

Figure 2.1: Cognitive development of high and low SES children

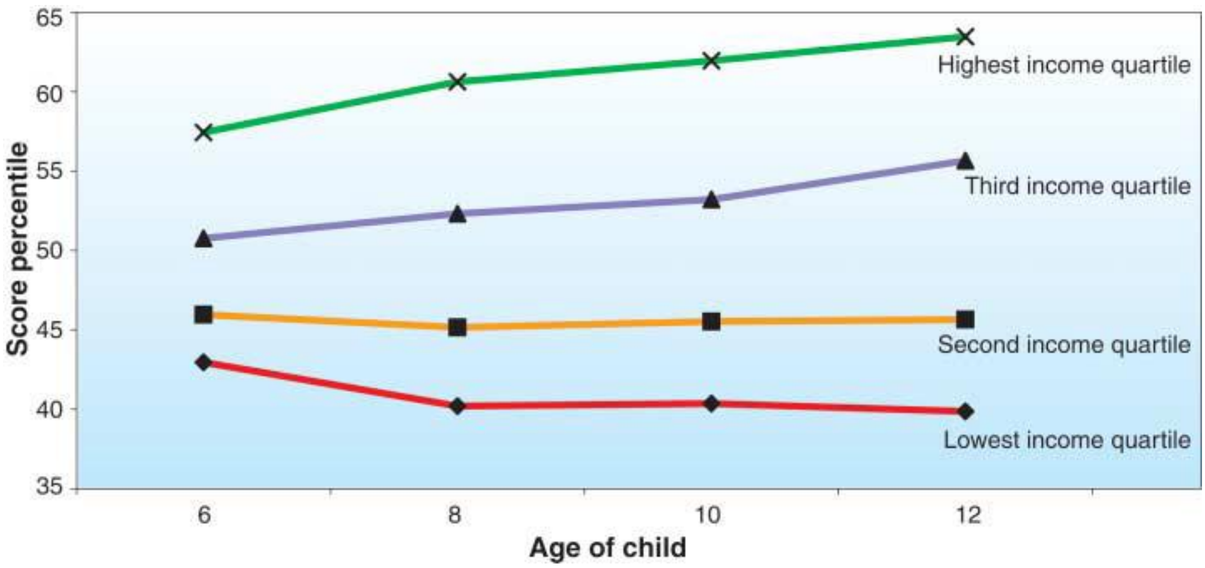


Source: Feinstein (2003: 85)

Perhaps the most disconcerting aspect of Feinstein's (2003) study was that he could find no evidence that initial inequalities were reduced by entry into the school system. Although Feinstein maintains that these results do not conclusively point to the best stage to implement policy interventions, the considerable degree of sorting and mobility that occurs between the age of 22 months and 42 months on the basis of SES might be taken as an indication that interventions should be employed as early as possible. Heckman (2006) argues for exactly this, based on a similar piece of analysis to that of Feinstein's.

Heckman (2006: 1901) considers that although much hope is often put in schools to reduce skills gaps on the basis of SES, the motivations and abilities derived from one's family background play a far stronger role in the determination of academic performance than do traditional school inputs, which are usually the chief focus in policy debates. Heckman (2006) demonstrates this using a similar figure to the Feinstein (2003) graph shown above. Figure 2.2 shows the average achievement ranking (score percentile) for different income quartiles at ages 6, 8, 10 and 12. Note that the same individuals were tracked from age 6 to 12 and the income quartiles were derived from the average of family income between 6 and 10 years of age.

Figure 2.2: Academic achievement by SES and age



Source: Heckman (2006: 1900)

Citing the data shown above, Heckman (2006: 1901) argues that gaps in achievement are already stable by the third grade and that schools are very limited in their ability to narrow these gaps thereafter. According to Heckman, the reason for this phenomenon is the hierarchical nature of learning with early cognitive development being the foundation for all subsequent learning. As Heckman (2006: 1900) puts it, "the mastery of skills that are essential for economic success and the development of their underlying neural pathways follow hierarchical rules. Later attainments build on foundations that are laid down earlier." He points out that the track records for various forms of adult education, such as criminal rehabilitation and adult literacy, are rather dismal. In contrast, early childhood learning programmes usually enjoy particularly high returns. Heckman (2006) therefore contends that interventions amongst disadvantaged children will have greater impact at earlier ages. Moreover, from the point of view of optimising resources, he argues that most societies are over-investing in adult education and under-investing in early childhood development.

Returning to the schematic diagram in Chapter 1 (Figure 1.4), the research by Feinstein (2003) and Heckman (2006) demonstrates that upon entering school considerable skills gaps already exist on the basis of SES – what Lee and Burkham (2002) characterise as "inequality at the starting gate." The extent to which these gaps widen or narrow during institutional education will depend on the effectiveness of the school system. This thesis examines snapshots at various stages of the school process in South Africa and also investigates trajectories from one snapshot to another. However, the importance of this for economic equity and mobility depends crucially on the link between snapshots 5 and 6 in Figure 1.4 – that educational attainment and quality determine labour market success. A substantial literature, including both international and South African studies, confirms that this is indeed the case.

2.5.1) The "Earnings Function" literature

The work of Schultz (1961) and Becker (1962, 1964) pioneered the human capital model, according to which education improves an individual's productivity and this leads to higher earnings. Following this logic, an extensive literature has sought to estimate the returns to education by modelling individual earnings on a number of characteristics, including gender, age, work experience and years of education. This type of model was popularised by Jacob Mincer (1974) with the result that "earnings functions" are often referred to as "Mincerian functions". The vast earnings function literature has consistently demonstrated a strong association between earnings and years of education, despite a debate about the causality underlying the association.[12] Hanushek and Woessman (2007: 2) weigh the evidence and nevertheless maintain that educational attainment, as well as the quality of schooling, is truly causally related to individual earnings.

[12] Some maintain that individuals invest in education in order to signal their ability to potential employers while conversely it has been argued that employers use education credentials to screen potential employees. "Signalling" and "screening" theories can be grouped together as "sorting" explanations of the returns to education and are usually erected as rival theories to the human capital approach, with varying degrees of mutual exclusivity. For a discussion of this debate see Weiss (1995).

A number of earnings function studies have been undertaken for the South African labour market. Focussing mainly on black South Africans, Bhorat and Leibbrandt (2001) estimated the impact of education on three separate labour market outcomes: the decision to participate in the labour market, whether one successfully finds employment and then earnings. This study demonstrated that education operates differentially at the different phases of the labour market. Primary and secondary level education was a significant predictor of the decision to participate in the labour market but not in the employment equation, indicating that while basic education may increase the probability of labour market participation it is not sufficient to secure a job. Tertiary education, however, strongly improved the probability of employment (Bhorat and Leibbrandt, 2001: 128). The earnings equation showed that for African people who were employed there were statistically significant and positive returns to primary education and larger returns to secondary education, as one might expect. The coefficient on tertiary education was not significant but this may have been due to the small number of Africans with tertiary education in the sample, according to Bhorat and Leibbrandt (2001: 128).

Mwabu and Schultz (2000) conducted another earnings function study using 1993 South African data. They found that despite large inter-race wage gaps, there were particularly high returns to additional years of education for black South Africans relative to white South Africans. Mwabu and Schultz (2000: 327) found that returns to secondary education were approximately twice as large for blacks than for whites: 16% versus 8% amongst males, and 25% versus 5% amongst females. Returns to additional years of tertiary education ranged from 29-40% for blacks compared with 14-15% for whites.

Despite these superior marginal returns to education for black South Africans, the overall racial employment and wage gaps remain telling. Using the 2000 Income and Expenditure Survey and the 2004 Labour Force Surveys, Burger and Jafta (2006: 3-4) calculated that average earnings for whites were almost double those of the second largest earnings group, Indians, and more than four times the average earnings of blacks. Table 2.2 presents the average amounts and distribution of wage earnings amongst the various race groups in South Africa.

Table 2.2: Racial decomposition of wage earnings in South Africa

Population group	Share of labour force (%)	Share of wage earnings (%)	Wage earnings *per capita* (Rands)
Black	76,3	41,2	2023
Coloured	10,0	9,9	2702
Indian	3,0	6,0	5092
White	10,7	42,9	8484

Source: Burger and Jafta (2006: 4)

The question remains: why do these substantial employment and wage gaps persist in the presence of an ambitious set of affirmative action policies? Using Oaxaca-Blinder decomposition methods, Burger and Jafta (2006) decompose the racial employment and wage gaps into a component explained by differences in educational attainment and productive characteristics and an unexplained component. Rather disconcertingly, they find no downward trend in the unexplained component of the racial employment gap since 1994. Although the unexplained component in such decompositions is often assumed to represent labour market discrimination, Burger and Jafta (2006: 20) speculate that this could be due in part to a low quality of education being received by black workers. As far as the racial wage gap is concerned, they similarly observe no significant closing of the gap or any downward trend in the unexplained component. Again, this is suggestive of an important case for improving the quality of education being received by black labour market entrants. Burger and Jafta (2006: 28) argue emphatically that, "any policy aimed at addressing the wage gap by focusing only on the labour market while neglecting to correct the inequalities in the educational system will necessarily fail to provide a sustainable solution to this problem."

Burger (2009) has attempted to estimate the role of school quality in the unexplained component of Oaxaca-Blinder wage decompositions. The index for school quality he proposed accounted for approximately half of the unexplained component of the racial wage gaps in South Africa. He therefore suggests that a great deal of what is commonly assumed to be labour market discrimination in fact represents another form of pre-labour market inequality. The impact of education quality, as opposed to simply years of schooling, on labour market performance in South Africa still requires further research.

Another important finding that has emerged from South African earnings function studies is that there is a convex structure of returns to education. This runs contrary to the traditional human capital model which predicts diminishing marginal returns to additional years of education. Both Lam (1999) and Keswell and Poswell (2002) have demonstrated that the returns to primary education in South Africa are very low and that strongly increasing marginal returns accrue at higher levels of education.

Lam (1999) explored the relationship between schooling inequality and income inequality in South Africa and Brazil, generally considered two of the most unequal societies in the world. Using earnings functions, he came to the unsurprising finding that schooling explained a great deal of the variation in earnings in both countries. More interestingly, Lam considered that a reduction in schooling inequality would not necessarily lead to a parallel reduction in income inequality. This perhaps surprising assertion is in fact a logical implication of convexity in the returns to education.[13] As Lam (1999: 23) argues, a large improvement in mean educational attainment will not necessarily affect the variance of schooling substantially. Appreciable returns on the labour market will still only be enjoyed by those at the top end of the educational distribution, leaving income inequality chiefly unaffected. Lam (1999: 23) observes that South Africa has had substantially less educational inequality than Brazil, but that this has not translated into a more equal income distribution. This is chiefly because of the convex structure of returns to education.

Similarly, Keswell and Poswell (2002: 20-21) consider some of the implications of convex returns to education for inequality. In the South African context, where there is a significant cost attached to acquiring education (especially at the higher levels), disparities in household wealth (and SES) determine who is able to reach the level of education that is high enough to be rewarded on the labour market. One implication of this scenario is that talented individuals from poor backgrounds might make a fully rational decision to drop out of school fairly early on, simply because the opportunity cost of attending primary and most of secondary school is greater than the returns such levels of schooling are likely to secure. With superior returns at higher levels of education, the rich have a greater incentive to acquire education than do the poor, thus reinforcing inequality. Given this convexity, Keswell and Poswell (2002: 20-21)

[13] Convexity in this context refers to the phenomenon that the *marginal* returns to additional years of education are increasing with years of education.

suggest that educational reforms and small-scale interventions are likely to have a negligible impact on income inequality.

2.5.2) South African studies on mobility

A doctoral thesis by Thomas Hertz (quoted in Solon, 2002) examined the contemporaneous association between the reported earnings of South African fathers and their sons. The study was limited by the fact that the sample consisted of fathers and sons that lived together and that a short run measure of earnings was used. Despite this, Hertz found a sizeable intergenerational elasticity estimate. Solon (2002: 64) maintains that this result is consistent with the expectation that intergenerational transmission of wealth is high in developing countries.

Other studies of intergenerational mobility define it as the extent to which family background (household income and parent education) can explain the schooling gaps of children. Thomas (1996: 332) made the case that intergenerational mobility, as defined by the influence of parental education attainment on child attainment, was higher among black and Indian South Africans than among the white and coloured race groups. He also argued that mobility had increased amongst black people born since 1950 and that this was evidence of a loosening in South African society even before apartheid had been dismantled.

Burns (2001) examined schooling gaps in the KwaZulu-Natal province using panel data from 1993 and 1998. She found that both household income and parent education were important determinants of schooling gaps, although the effect of parent education was more substantial. Interestingly, this study found that having a poorly educated mother and well educated father was as beneficial as having two well educated parents.

Van der Berg, Louw and Yu (2006) also examined intergenerational mobility in South Africa as proxied by the impact of parental educational attainment on child attainment. Although they present evidence of declining inequality in educational attainment since 1970 due to increases in attainment amongst black, coloured and Indian people, they show that parental education continues to be a powerful influence on attainment, thus constraining mobility.

Solon (2002) suggests three reasons why one country may have a higher steady state intergenerational elasticity (i.e. less mobility) than another. It may be due to greater heritability, for example owing to "assortive mating" (where people marry or partner with others with similar characteristics, such as SES). Secondly, Solon (2002: 65) maintains that higher earnings returns to education may cause greater intergenerational elasticity. Thirdly, the extent to which public spending is progressive may influence mobility. Corak and Heisz (1999, quoted in Solon, 2002: 65), for example, have suggested that progressive public spending in Canada has contributed to greater mobility in that society.

Applying Solon's three possible factors affecting mobility to South Africa, one might expect the high level of progressive government spending, including on education, to contribute strongly to greater mobility. However, despite the progress that has been made with respect to fiscal equity, several economists studying education have recognised that increased inputs have not translated well into equity of educational outcomes (for example, Van der Berg, 2002; Fiske and Ladd, 2004). Moreover, South Africa has a high degree of assortative mating. Based on calculations from the Community Survey of 2007, it was estimated that the correlation between own educational attainment (years of education) and that of partners was 0.86. Substantial labour market returns to education are available to those who persevere to the high secondary and tertiary levels, while returns to additional years of primary and secondary schooling in South Africa are low. This convex structure of returns means that improvements in the mean level of education may not necessarily lead to a decrease in inequality, as Lam (1999) has observed. More extensive improvements in the educational outcomes of poor children may be required before greater equity and mobility is experienced.

Given a high level of assortative mating, progressive but largely ineffective education spending and a convex structure of returns to education, the extent to which educational inequalities are aligned with SES is a good indication of the prospects for future mobility in South Africa. Ultimately what is at stake is the country's economic development, which is concerned with raising the living standards of the whole population, especially for the poor. Against the backdrop of this theoretical framework, this thesis examines the influence of SES on educational achievement in South Africa. But first it is worth noting that numerous authors are explicitly critical of the role of formal schooling in social mobility.

2.5.3) Critical perspectives on the role of schooling in social mobility

Thomas Piketty (2000) argues that debates about the role of schooling in development and mobility have been subordinate to a broader intellectual conflict between the "liberal theory of industrialisation" and Marxist or socialist theories. According to the liberal theory, free markets are characterised by rationality, efficiency and openness that promote personal freedoms and material prosperity, including rising mobility. In Marxist theory, capitalist societies are characterised by class reproduction, which is fostered by institutions such as schooling. Carnoy (1982: 81) summarises the Marxist view: "children go to school at an early age and are systematically inculcated with skills, values, and ideology which fit into the type of economic development suited to continued capitalist control." Underpinned by variations of this view, numerous "reproduction theories" of schooling emerged during the 1970's and 1980's.

One of the most influential works in this tradition was *Schooling in Capitalist America* by Bowles and Gintis (1976). They proposed a "correspondence principle", which held that social interactions and rewards in school were structured so as to replicate the working environment of a capitalist system. This would socialize individuals to be compliant whatever their position in the economy. Other critical theorists have emphasized that reproduction through schooling is not only economic but also cultural. Callewaert (1999: 140) explains that the sociology of Pierre Bordieu went beyond merely describing the way social inequalities are reproduced through educational inequalities. According to Bordieu, there is an illusion of justice and merit in schools. It is not a fair competition because middle class culture is taught, which is more easily assimilated by children who have inherited a middle class culture at home. Basil Bernstein (1982) also saw the deterministic tendencies embedded in school systems and was interested especially in the relationship between the economic and cultural aspects of reproduction. For Bernstein, a complex system of codes and social rules that operate in schools serves to position individuals within the division of labour and cultural milieu, influenced by SES but also by factors such as gender and ethnicity.

At their extremes, both liberal and Marxist theories have now been largely discredited. The considerable rise in living standards experienced in capitalist countries stands in stark contrast to the resounding failure of communist systems of government based on central planning. The ultimate collapse of the Soviet Union "concluded a vast experiment," as Alan Greenspan (2007:

141) put it – "the long-standing debate about the virtues of economies organized around free markets and those governed by centrally planned socialism is essentially at an end... the verdict on central planning has been rendered, and it is unequivocally negative." On the other hand, more decentralised economies have not delivered a great rise in mobility and social inequalities have undoubtedly been reproduced, to varying extents. Bowles and Gintis (2002a) have revised their earlier work in the light of what is now known about economic systems. They concede that an alternative economic system may not be feasible but rather that reforms to capitalism may be the best framework for pursuing economic and educational objectives.[14]

The next chapter examines the extent to which the school system in South Africa is likely to contribute to real opportunities for upward mobility amongst the poor. The level of educational achievement reached amongst poor children from disadvantaged backgrounds is one indicator of the contribution of the education system to future mobility and economic development. The focus on test scores as an outcome of interest through much of this thesis does not reflect a value judgement that "only that which is measurable is important," an assumption that Apple (2005: 11) cautions against. A high quality education contributes to the expansion of human capabilities in many more ways than merely economic success, as it was contended in Chapter 1. Yet, literacy and numeracy skills are rewarded in the South African economy and in the global economy. Attaining these skills does therefore represent one channel to expand human capability and economic development. This is not to say that these forms of knowledge and skills are intrinsically superior to other knowledge such as indigenous knowledge. It is also beyond the scope of this thesis to outline or argue for the most desirable economic system. It has been considered, however, that a reasonable weight of evidence suggests that the historical expansion of an economy based on decentralised cooperation has spread many benefits throughout the world. This thesis proceeds on the basis that the more people that can be included in this process of development through acquiring marketable skills the better.

[14] It is important to distinguish liberal and Marxist theories as frameworks for interpreting social and economic phenomena from liberal and Marxist blueprints of how the economy should be organised. At their extremes, the latter have been discredited, but this does not invalidate the concerns of critical education theorists. It does, however, affect how one responds to the problems identified by critical reproduction theories of education. Instead of viewing the market economy as the fundamental problem, reforms to schooling that promote greater equity can take place within the context of a society characterised by decentralised cooperation. This is essentially the realisation of Bowles and Gintis (2002a).

CHAPTER 3: SOCIO-ECONOMIC STATUS AND READING ACHIEVEMENT IN SOUTH AFRICA[15]

3.1) The Progress in International Reading Literacy Study (PIRLS 2006)

This chapter examines equity in South Africa's educational achievement, and specifically the association of reading achievement with SES, by drawing on the PIRLS 2006 survey. This survey is one in a in a tradition of large-scale sample surveys of educational achievement that have been conducted by the International Association for the Evaluation of Educational Achievement (IEA), including the first round of PIRLS in 2001 and three rounds of TIMSS[16], which have been the subject of considerable educational research.

The chief objective of PIRLS was to provide countries with information about reading achievement in primary schools that would be relevant to policy and classroom practice. To this end PIRLS surveyed reading achievement amongst fourth grade students in 40 countries. The two education systems within Belgium were analysed separately and the five provinces of Canada were also independent participants. There were thus 45 participants in total. Altogether over 215,000 students in approximately 7,700 schools were surveyed.[17] Only two African countries participated in PIRLS 2006 – South Africa and Morocco. The South African sample included 14,657 students in 397 schools. It is important to note that in South Africa and New Zealand testing was administered to students in grade 5 instead of grade 4. In the case of South Africa, the IEA cited the challenging context of having multiple languages of instruction as the reason behind this decision.[18]

The reading test could be written in the preferred language chosen by each school. In the case of South Africa the test was available in all 11 official national languages. The numbers of students writing in each language is shown in Figure 3.1. English was the most common language chosen, yet it is likely that a large proportion of this group were not mother-tongue

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[15] The author is grateful to Derek Yu for initial work on the PIRLS data. The first dissemination of the research in this chapter was a joint paper (Taylor and Yu, 2009).

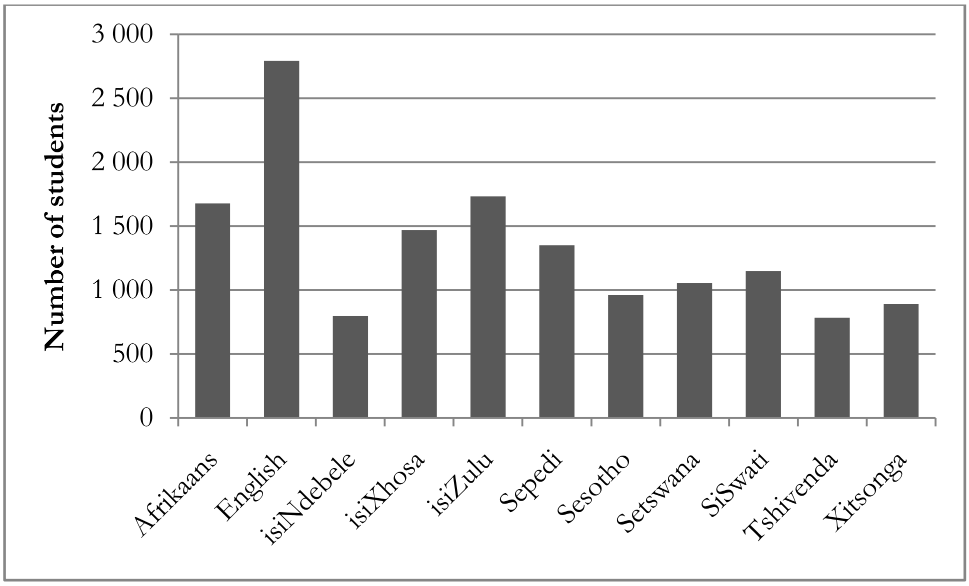
[16] The three waves of the Trends in International Maths and Science Survey were released in 1995, 1999 and 2002.

[17] A set of weights was provided to ensure that the sample could be scaled up to be representative of actual population size so that subgroups are proportionally represented. Therefore, where appropriate, the total student sampling weight called "totwgt" was applied in the analysis in this chapter.

[18] It would perhaps have been better to test grade 4 students in South Africa and treat the issue of multiple languages of instruction as one factor contributing to educational achievement, rather than to somehow build this into the design of the survey.

English speakers but that the schools nevertheless felt it was the most appropriate language in which to be tested.

Figure 3.1: Frequency distribution of the South African PIRLS sample by language of the test



In addition to testing the reading achievement of students, a wide range of information on student and school characteristics was collected. In total, six survey instruments were administered including the reading test booklet. A student questionnaire captured demographic information as well as information about home background and school activities. Another questionnaire was sent home with children for their parents or guardians to complete. This focussed on the type of educational support and literacy activities available to students at home. The school, teacher and curriculum questionnaires captured institutional information at the school level.

A fairly complex procedure was followed in the calculation of the overall reading scores. PIRLS wanted to test students on 126 assessment items. However, the estimated time this would take a student to complete is 400 minutes. In order to deal with this, items were divided into 10 test blocks. These ten blocks were then distributed across 13 test booklets – two blocks in each booklet – with as many different combinations of blocks as possible. Using Item Response Theory (IRT), the scores were then imputed as if the students had answered all 126 items. This inevitably leads to a small degree of error. Therefore, in order to provide researchers with some indication of the bias this imputation causes, five different plausible values were imputed. The reading scores presented and used for analysis in this chapter were calculated by taking the mean of the 5 plausible values. The reading scores were set by the IEA to have a scale average score of 500 across the countries and a standard deviation of 100.

The reading test booklets consisted of short passages of text accompanied by a set of comprehension questions. The questions were in either multiple choice or constructed response format. Educational experts identified four points on the reading score scale as benchmarks corresponding to various levels of proficiency in reading and comprehension. Table 3.1 shows the four benchmarks and provides a very brief description of the level of ability required to achieve each benchmark. A much more extensive description is to be found in the official PIRLS documentation (Mullis *et al*, 2007).

Table 3.1: Description of International Benchmark scores in PIRLS

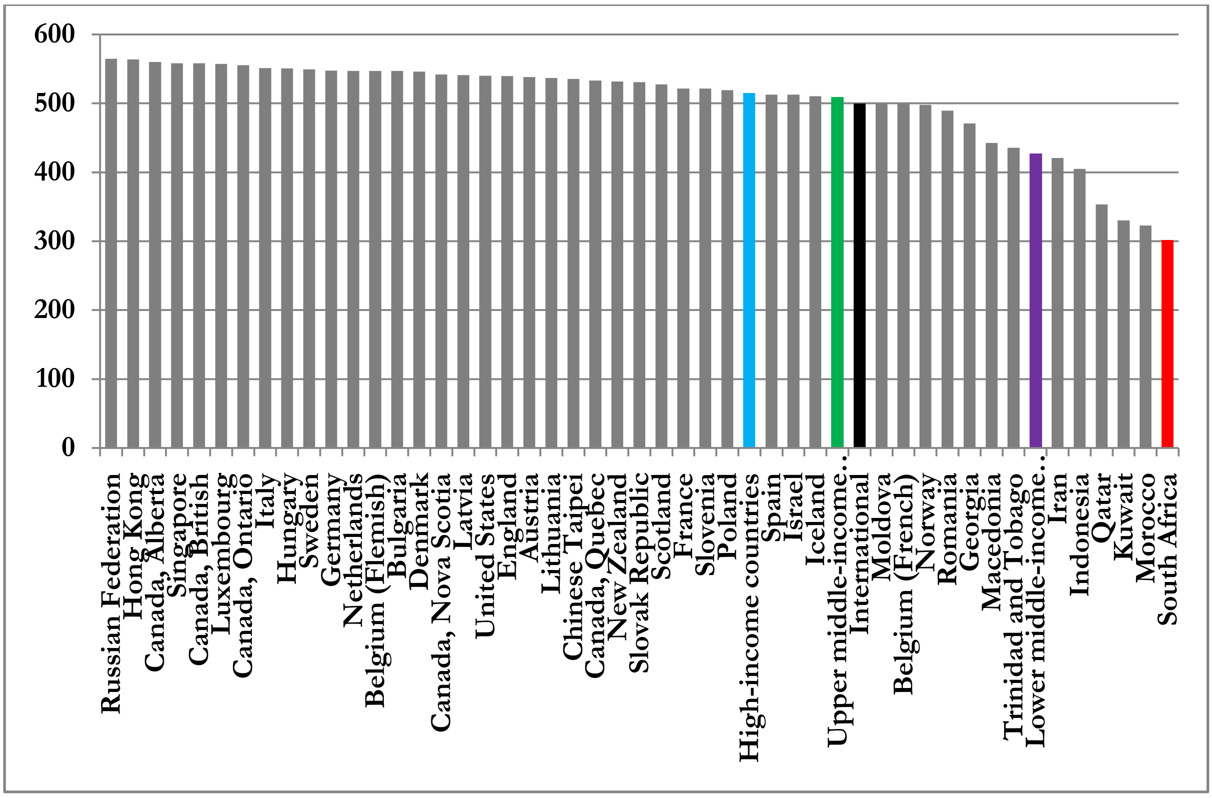
Benchmark	Score	Description of demonstrated proficiency
Low International Benchmark	400	Able to recognise detail and make inferences plainly suggested in the text.
Intermediate International Benchmark	475	Able to make basic connections between details, events and sequences in the text.
High International Benchmark	550	Able to interpret, evaluate and integrate details and abstract ideas and substantiate these.
Advanced International Benchmark	625	Able to interpret complex information and figurative language and to justify preferences.

Source: Summarised from Mullis *et al* (2007)

3.2) Overview of PIRLS 2006 country performance

The top-performing participant in PIRLS 2006 was Russia with a national average reading score of 565. On the other end of the spectrum, the worst performing participant was South Africa with a national average score of 302. This score is effectively two standard deviations below the international mean and one standard deviation below the low international benchmark. This result is not out of line with other international surveys of educational achievement in which South Africa has participated. In TIMSS 2002 South Africa registered the lowest mean scores in both grade 8 mathematics and science achievement, also about 2 standard deviations below the mean of the participating countries. In the SACMEQ II survey of grade 6 mathematics and reading achievement in 14 Southern and East African countries, South Africa performed at a level slightly below the mean for the region. The low overall level of achievement demonstrated by South African children is in itself a motivating factor for an investigation into the association of SES with educational achievement in this country. Figure 3.2 presents the mean reading scores for all the participants in PIRLS as well as the mean scores for high income countries, upper-middle income countries and lower-middle income countries according to World Bank classifications.[19]

Figure 3.2: Mean country reading scores in PIRLS 2006



An alternative way of describing the overall results is provided by Figure 3.3. This shows the percentage of pupils in each international benchmark category. Singapore and Russia have the greatest proportion of students in the top international benchmark category (19.4% and 18.9% respectively). In contrast, the countries with the largest percentage of students failing to reach the Low International Benchmark category are South Africa (77.8%), Morocco (74.3%) and Kuwait (71.8%). Children not attaining the low benchmark should be considered a vulnerable group as they are unable to recognise and reproduce even simple information in a text. Kathleen

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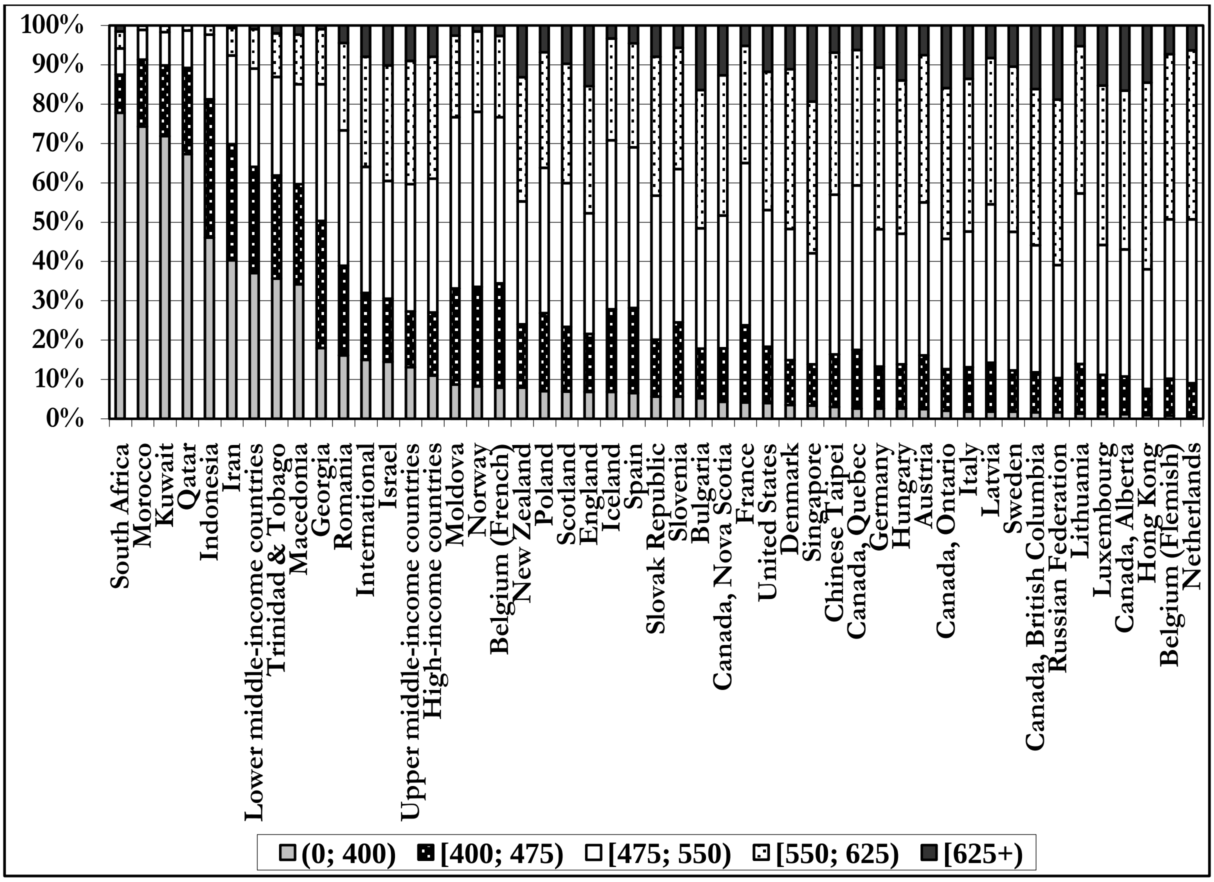
[19] A more detailed table of the overall PIRLS results is provided in Appendix A.

Trong (2009: 104) suggests that children scoring less than 400 in PIRLS are "at serious risk of not becoming literate." Nearly 80% of South African children find themselves in this vulnerable position.

Figure 3.3: Percentage of students below each benchmark score by country



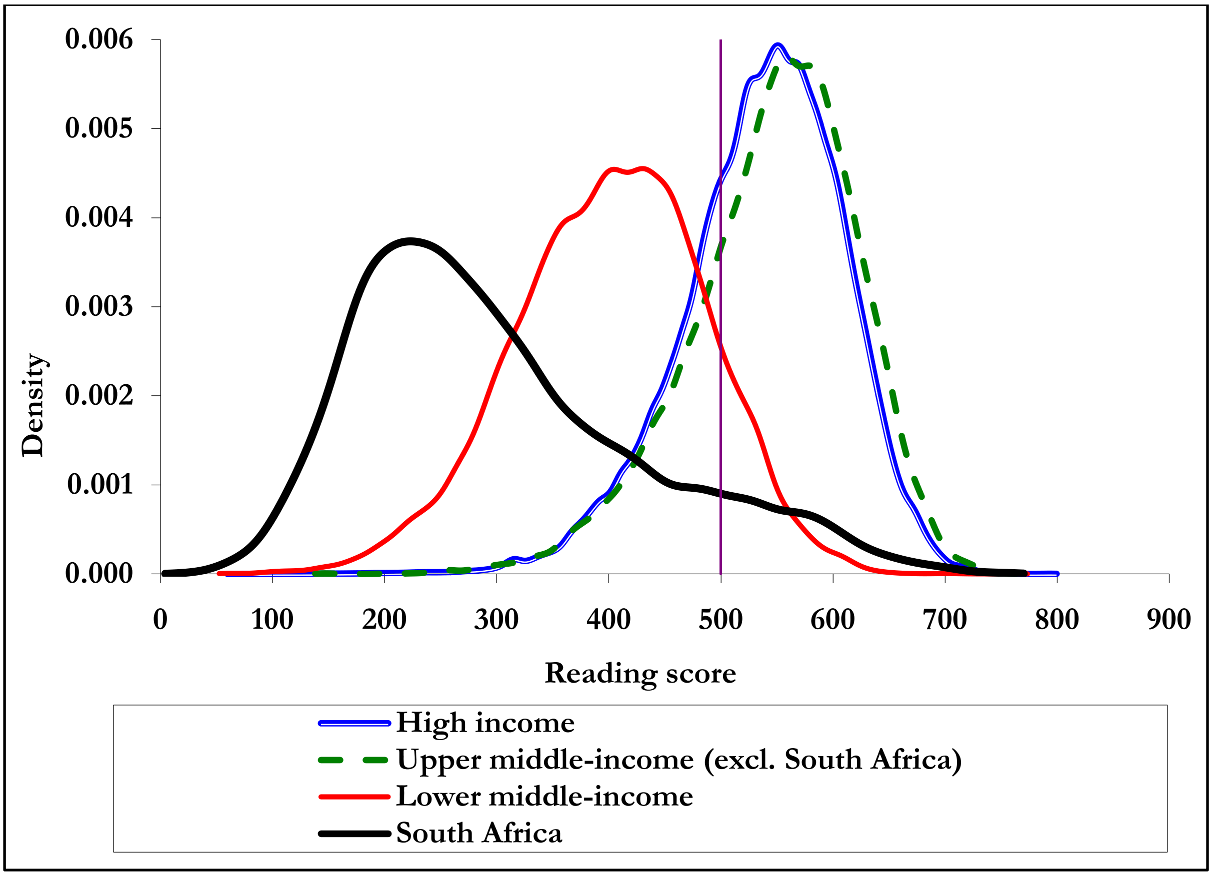
In Figure 3.4 the distributions of reading scores for South Africa and the three income categories of countries are portrayed using kernel density curves.[20] As the figure shows, the distribution of reading scores for South Africa lies far to the left of the other distributions, even in comparison with the lower-middle income group.[21] This reflects the fact that the bulk of South African children are performing at a very low level. As South Africa fits into the upper-middle income category it can be said that reading achievement in this country is considerably lower than what would be expected given *per capita* income. The other noteworthy difference with South Africa's

[20] A kernel density curve can be thought of as a smoothed version of a histogram. For an explanation of kernel density curves see Appendix B.

[21] It may seem surprising that the Kernel Density Curve for the high income group lies slightly to the left of that for the upper-middle income group. This result is largely attributable to the poor performances of Qatar and Kuwait – both high income countries.

kernel density curve is that it is much flatter, especially on the right hand side of the distribution. This indicates that although the bulk of performance is very low there are also groups of students performing at substantially higher levels. This is evidence of the well-known educational inequality that persists in South Africa. Indeed, South Africa has the highest variance and standard deviation (136) of all the participants in PIRLS 2006.[22]

Figure 3.4: Kernel density curves by country income groups

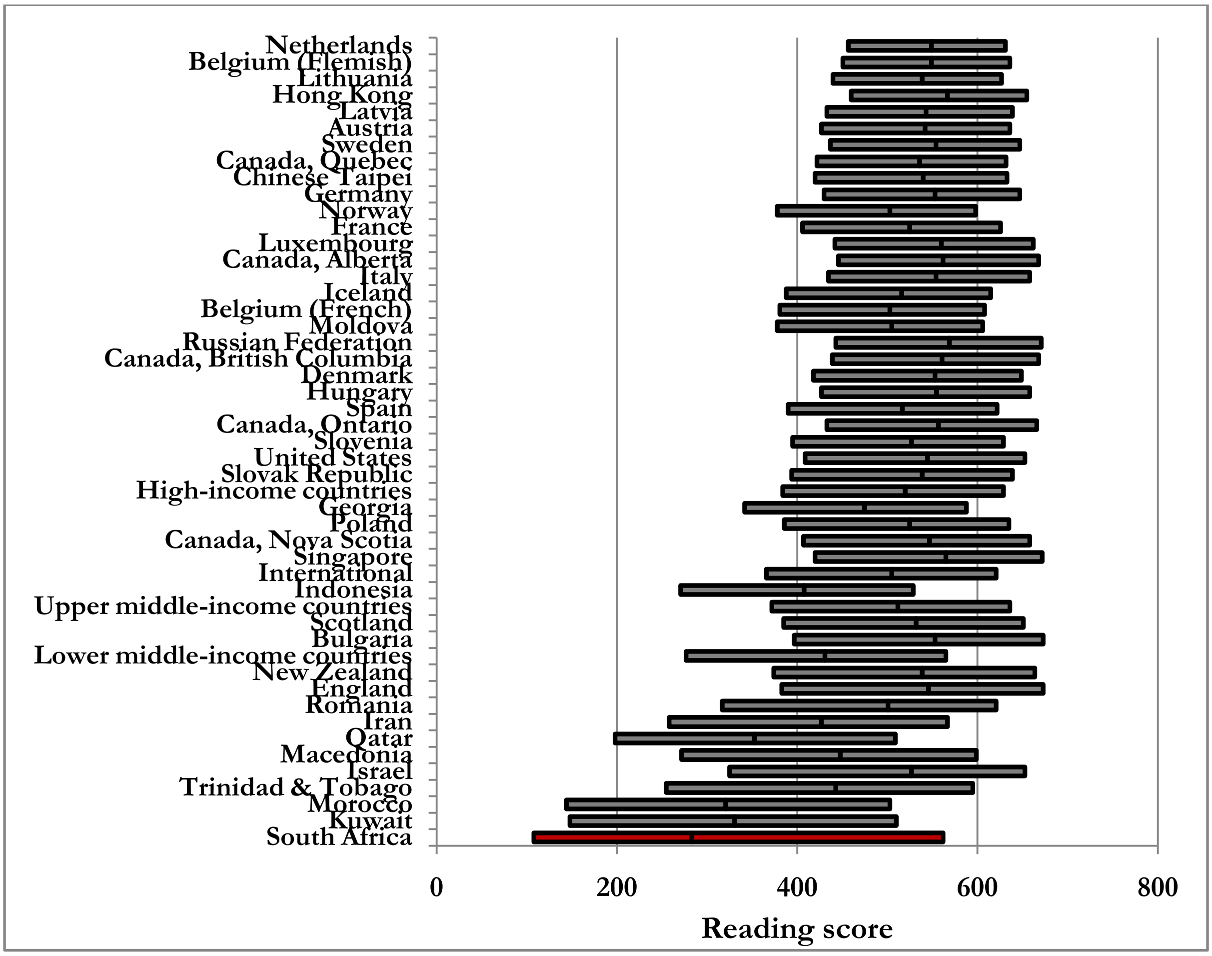


The great variation in reading scores for South Africa is again demonstrated in Figure 3.5. Here the countries are arranged by the size of the difference in reading scores between the 5th and 95th percentiles. The lower limit of each country's bar is the reading score at the 5th percentile and the upper limit of each bar is the reading score at the 95th percentile. The 50th percentile is also indicated within each bar. It is evident that the low performers in South Africa are performing worse than the low performers in all the other countries. The reading score at the 5th percentile for South African students is 108. Considering that the international average is set at 500, that the Low International Benchmark value is 400, and that many of the test questions were in

[22] Recall that the overall average standard deviation was set at 100.

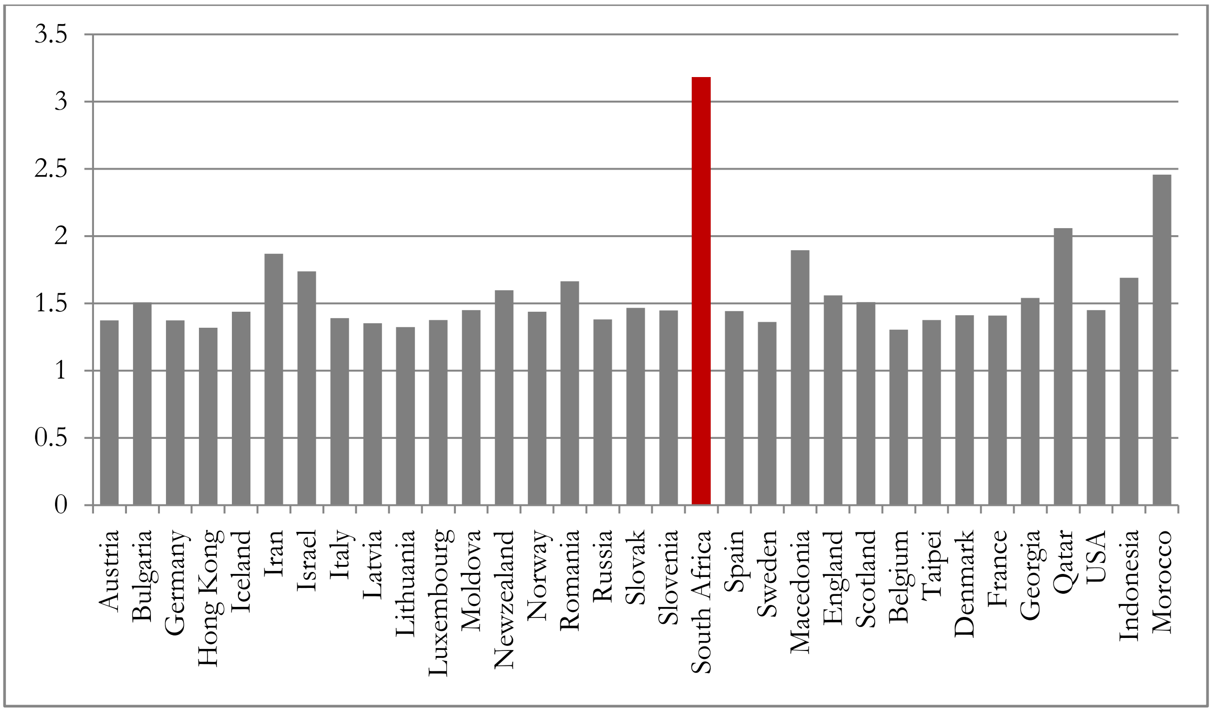
multiple choice format, this result indicates that a not insignificant proportion of grade 5 students enrolled are effectively illiterate. Moreover, South Africa exhibits the greatest difference between the 5th and 95th percentiles, suggesting that educational achievement is inequitably distributed by international standards. It is also interesting that the gap between the median and the 95th percentile spans nearly 300 points for South Africa, pointing to the reality that the top-performing part of the education system is doing far better than the less well-performing part, which is the majority.

Figure 3.5: 5th, 50th and 95th percentiles of reading achievement by country



The degree of equity in educational achievement in any particular country or group can also be expressed as the ratio of the average score of the top-performing 20% relative to that of the bottom-performing 20%. These ratios were calculated for a selection of countries in PIRLS and are reported in Figure 3.6. South Africa is again an outlier amongst the countries in PIRLS, with the average score for the top 20% being more than three times higher than that of the bottom 20%.

Figure 3.6: "Top 20%: Bottom 20%" reading achievement ratios by country



This overview of country performance in PIRLS 2006 indicates that reading achievement amongst most South African children is at a very low level and that the distribution of achievement is highly inequitable by international standards. This does not necessarily imply anything about the association of SES with educational outcomes, although the question will surely arise in the mind of a curious observer. This is the major focus of the forthcoming analysis.

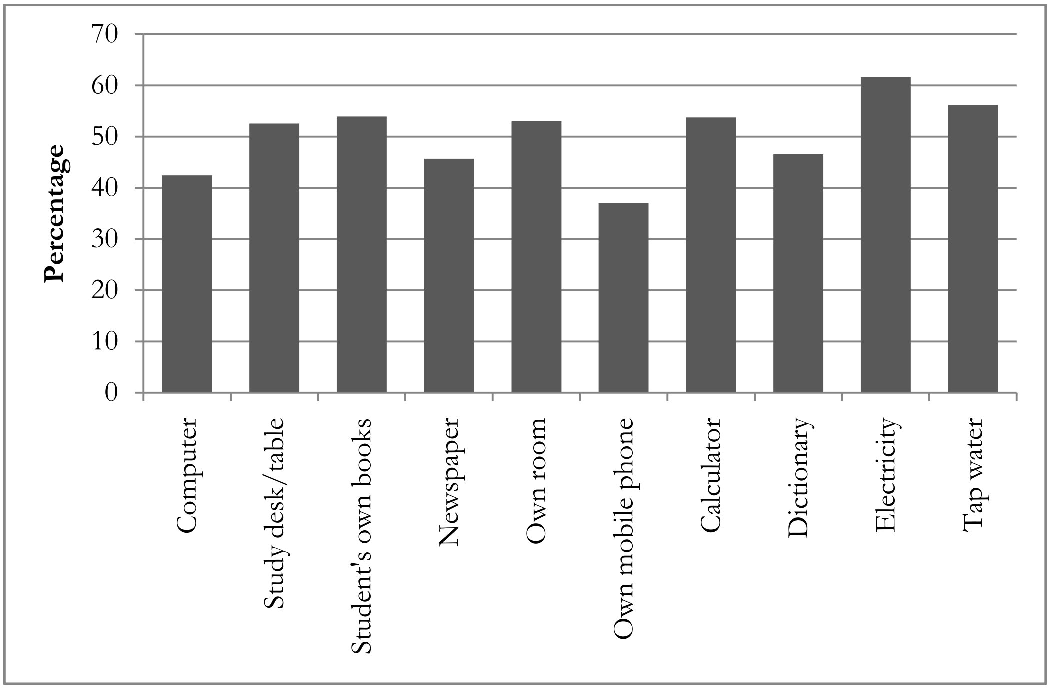
3.3) Measuring SES in educational surveys such as PIRLS

An important methodological issue permeating much of the analysis presented in this thesis is the derivation of a measure for SES. Large surveys of educational achievement such as PIRLS, TIMSS and SACMEQ typically do not contain information about household income or expenditure. Students can certainly not be expected to provide reliable income or expenditure information. Even in household surveys in which each household is visited it is difficult to collect income data accurately. There are also problems posed by factors such as non-response that is not random and by the complexity introduced by multiple sources of income. These considerations, together with the fact that income is subject to short term fluctuations, have the effect that analysts often prefer to use consumption or expenditure data as a proxy for SES, even when income data are available. However, the collection of consumption or expenditure data also carries a fairly heavy burden of time and cost. Although in PIRLS a questionnaire was sent home with students for parents or guardians to complete, no question regarding income or expenditure was included.

It is increasingly common to construct an asset-based index of SES when the data are suitable. This is possible using surveys such as PIRLS, TIMSS and SACMEQ, where questions are asked regarding the presence of certain household items at each student's home. Filmer and Pritchett (2001) set forth a strong case that asset-based classifications of households correspond closely to classifications by expenditure, and that asset-based indices are in fact better at predicting educational attainment than are expenditure data. One reason for this is that the presence of household assets is a more stable indicator than income or expenditure and therefore a better proxy for SES, which is fairly unresponsive to short-term household income shocks. This is a reassuring finding from the point of view of investigating the effects of SES on education using surveys of educational achievement, where income and expenditure information is typically unavailable.

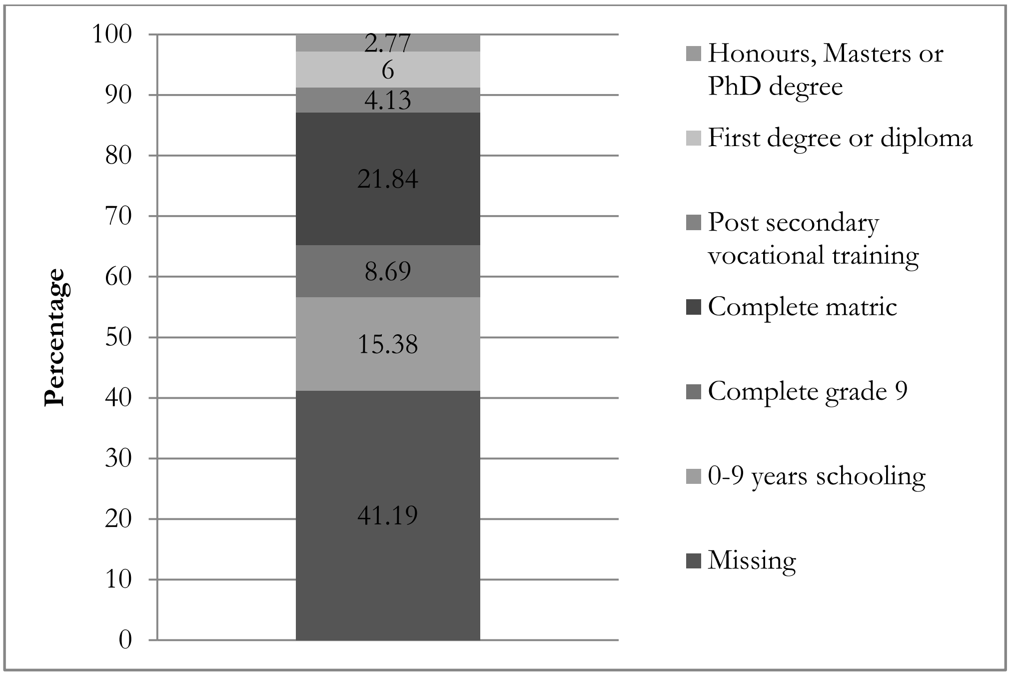
In PIRLS there are three sets of variables that are suitable candidates to proxy for SES. The first is a set of questions in the student questionnaire asking about the presence of ten items at home. The first six items were the same for all countries in PIRLS, while the last four items were country-specific in order to ensure a suitable amount of variation within each country. The ten items for South Africa are displayed in Figure 3.7 together with the proportion of the South African sample that reported having each item at home.

Figure 3.7: Proportion of South African students having certain household assets in PIRLS



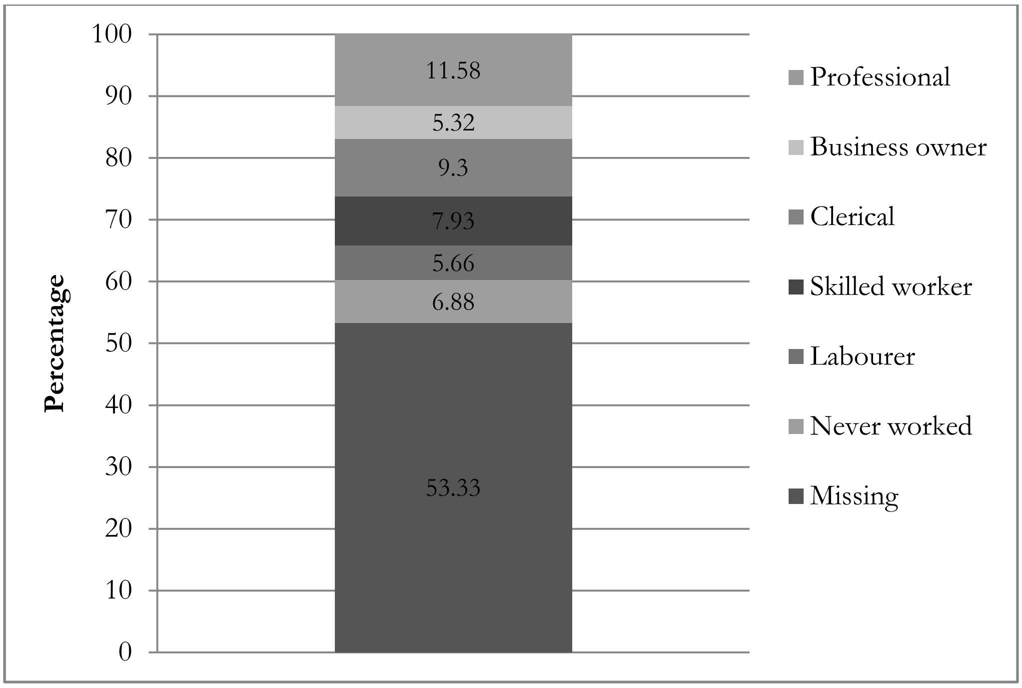
A second variable that is available in PIRLS and that is commonly used to proxy for SES is the highest educational attainment of each parent. The information on mother's education can be combined with that for father's education to form a single variable for the highest educational attainment of either parent. The proportion of parents fitting into each category of educational attainment for South Africa is depicted in Figure 3.8. A striking feature of the figure is that there is no information on parental education for over 40% of the South African sample. This high rate of non-response detracts from the suitability of this variable to feed into a measure of SES. Otherwise, the distribution of attainment is in line with what one would expect in South Africa – for example, there is a large concentration at the matric level, which has traditionally been and remains a significant threshold in South African education.

Figure 3.8: Highest educational attainment of either parent (South Africa)



Parent occupation, another commonly used proxy for SES, was also enquired about in PIRLS. The South African sample, however, was again plagued by a very high rate of non-response: no information is available for over 53% of the sample. Figure 3.9 shows the proportions of South African parents in PIRLS fitting into each occupational category.

Figure 3.9: Occupational status of parents (South Africa)



When constructing a single index from variables such as those described above, a decision needs to be taken about how to weight each variable in the index. A simplistic approach would be merely to sum the variables, thus attaching equal weight to the variables if they had identical coding. The shortcomings of such an approach are immediately apparent. For example, it is likely that an asset owned by 98% of households would be less useful in differentiating SES than an asset that is owned by 50% of households.

The solution to the question of weighting applied when constructing SES indices in much of this thesis is to use Principal Component Analysis (PCA). This technique attaches more weight to the variables that are less equally distributed, i.e. the greater the standard deviation of the variable the greater the weight it is given in PCA (Vyas and Kumaranayake, 2006: 461). In PCA the range of variables is analysed so as to extract those linear combinations of the variables that capture the most common information (Filmer and Pritchett, 2001: 6). Each linear combination or "principal component" is orthogonal to the others, thus capturing different dimensions in the data. The first principal component explains the most variation in the data with successive components explaining additional but less variation (Vyas and Kumaranayake, 2006: 460). Assuming a set of variables, X_1 to X_n, each principal component takes the form of equation (3.1):

$$PC_m = w_{m1} X_1 + w_{m2} X_2 + \ldots + w_{mn} X_n \qquad (3.1)$$

where, w_{mn} is the weight for the *n*th variable within the *m*th principal component (adapted from Vyas and Kumaranayake, 2006: 460). In this analysis only the first principal component (PC_1) is used for the construction of an index for SES. This is based on the assumption that the concept underlying the linear combination with the most common variation amongst the household possessions, parent education and parent occupation variables is SES. Put differently, it is assumed that the SES of each student's family causes the majority of the variation in these variables. The first principal component is thus given by:

$$PC_1 = w_{11} X_1 + w_{12} X_2 + \ldots + w_{1n} X_n \qquad (3.2)$$

The weights derived from the PCA are applied to the following formula for the overall SES index for each household *i*:

$$SES_i = \frac{w_{11} * (x_{i1} - x_1)}{s_1} + \ldots + \frac{w_{1n} * (x_{in} - x_n)}{s_n} \qquad (3.3)$$

where w_{11} is the weight awarded to the first variable within the first principal component as determined in equation (1), x_{i1} is the value household *i* takes for variable 1, x_1 is the mean value of variable 1 for all households, and s_1 is the standard deviation for variable 1 over all households (adapted from Filmer and Pritchett, 2001: 6).

For the purposes of analysis, two competing indices for SES were derived and considered for use. The first was derived from PCA on only the household items variables while the second was derived by applying PCA to parent education and parent occupation. The criteria for choice between these two indices were in the first instance, the suitability of each index for analysis of the South African sample and, in the second instance, the suitability of each index for the analysis of the cases of Russia, Morocco and the USA. The latter consideration arises because these countries were selected for comparative analysis against South Africa, as presented in the following section. Russia was chosen because it was the best performer in PIRLS 2006. Morocco was selected due to its similarity to South Africa in that it was the only other African participant in PIRLS and that it registered the second lowest average achievement after South Africa. The USA was chosen for comparison because much is already known about educational outcomes in the USA, in particular that educational outcomes vary substantially with SES (e.g. Willms, 2004).

The use of the SES index based on the educational attainment and occupation of parents has three major disadvantages. Firstly, there is no information on parent attainment or occupation in the case of the USA, effectively relegating this country from analysis if this measure of SES is used. Secondly, as suggested by Figures 3.8 and 3.9, more than half of the South African sample is lost due to parent non-response. To some extent this can be dealt with in the case of parent education by imputing the mode of parent education within each school. This is justifiable for South Africa where highly variable school fees means that family SES is a driving factor in school selection. However, no such imputation seemed justifiable to deal with non-response on occupation. Thirdly, applying PCA to parent education is a contentious process with a methodological decision needing to be taken on how the parent education variable should be coded when entered into PCA. Appendix C describes these issues and the derivation strategy that was ultimately adopted.

The two indices were thus derived for South Africa, Morocco and Russia. Note that for the purpose of comparison both indices were derived using only those observations for which parent occupation information was available. Table 3.2 reports the correlations amongst the competing indices once they have been ranked into percentiles and student reading score for each country.

Table 3.2: Correlation coefficients amongst competing SES indices and student reading score

	South Africa	**Morocco**	**Russia**
SES1 – SES2	0.36	0.33	0.28
SES1 – Reading score	0.55	0.15	0.20
SES2 – Reading score	0.51	0.30	0.32

Note: SES1 = SES index based on ten household asset variables
SES2 = SES index based on parent educational attainment and occupation

Moderate correlations between the two SES indices were obtained for all three countries, with the highest for South Africa. The asset-based SES index displayed a somewhat higher correlation with reading achievement than did the parent attainment and occupation index for South Africa. However, in Morocco and Russia the latter index was more closely correlated with reading achievement. This presents a case for the use of parental education and occupation in these two countries, although perhaps not one strong enough to contend with the disadvantages described above. Further consideration of the merits of the two measures of SES is presented in the next section on socio-economic gradients.

3.4) Socio-economic gradients

A socioeconomic gradient is a graphical representation of the relationship between SES and a particular outcome of interest, such as health or education. Willms (1997, 2004) and Ross and

Zuze (2004), amongst others, have recently applied variations of this technique to portray the effect of SES on educational achievement. In order to create a simple linear socio-economic gradient one plots the estimates derived from an Ordinary Least Squares (OLS) regression equation with the following form:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 SES_i \qquad (3.4)$$

Where $\hat{Y}_i$ is the outcome of interest, $\hat{\beta}_0$ is the intercept and $\hat{\beta}_1$ is the coefficient on the proxy for SES, which determines the slope of the line once plotted. When running an OLS regression of this form for South Africa using the PIRLS reading scores and the asset-based index for SES (derived with PCA and divided into percentiles) the following estimates were obtained:

$$\hat{Y}_i = 198.49 + 2.08 * SES_i$$

The interpretation of this is that a one percentile increase in SES is associated with an increase in the expected reading score of 2.08 points. The basic socio-economic gradient for South Africa using these estimates is presented in Figure 3.10a.

According to Willms (2004: 7), three aspects of socio-economic gradients provide interesting information about the relationship between SES and educational achievement. The *level* or height of the line captures the overall level of performance for the education system. The *slope* indicates the extent to which reading scores vary with SES. The slope is therefore a measure of the educational inequality associated with SES. As already mentioned, the slope coefficient of 2.08 means that for every one percentile increase in SES the predicted reading score increases by 2.08 points. The *strength* of the gradient refers to how much of the variance in reading scores can be attributed to SES. The R-squared statistic is a commonly used and simple indicator of the strength of the relationship. This value is 0.2256 suggesting that about 22% of the variation in reading scores is due to SES when it is entered linearly into an OLS regression.

The significance of the South African socio-economic gradient is better understood in a comparative perspective. For this purpose, socio-economic gradients were constructed for three other countries using the same procedure. Principal Component Analysis of the ten household item variables (including four country-specific items) was used to generate an SES index for each country. Each index was then divided into percentiles within each country. This means that the SES rankings on the x-axis are not directly comparable across the countries, i.e. a South African with median SES and an American with median SES are not equally affluent, but they do occupy the same position relative to others within their respective societies. The gradients for Russia, Morocco and the USA are presented alongside the South African gradient in Figure 3.10b. The estimates and regression statistics are presented in Table 3.3.

The first striking feature of Figure 3.10b is that the levels of the gradients are significantly higher for Russia and the USA than for Morocco and South Africa. This reflects the large gap in the overall level of performance between these countries as Figure 3.2 has already demonstrated. Secondly, South Africa has by far the steepest gradient. The USA is next with a slope coefficient of 0.79. This means that a change in the SES ranking in South Africa is associated with a much greater change in the expected reading score than is the case for the same change in SES ranking in the other countries. Thirdly, the strength of the relationship between reading achievement and SES is greatest for South Africa, as indicated by the R-squared statistics. These values were low for Russia and Morocco, indicating that very little of the variance in reading scores is attributable to differences in SES. The R-squared statistic was somewhat larger for the USA, where approximately 10% of the variance in reading scores was accounted for by SES under this model specification. This is consistent with research by Willms (2004: 8), who found that the strength of the SES gradient for the USA was significantly greater than that for Canada. It is significant, then, that the strength of the relationship for South Africa appears to be more than twice that for the USA.

To summarise, South Africa registers the lowest overall level of reading achievement in PIRLS. It also has the highest variance in achievement of all the countries. Comparatively speaking, reading achievement varies widely with SES in South Africa. Moreover, SES explains more of the overall variance in reading scores in the case of South Africa than elsewhere.

Figure 3.10a: Basic SES gradient for South Africa

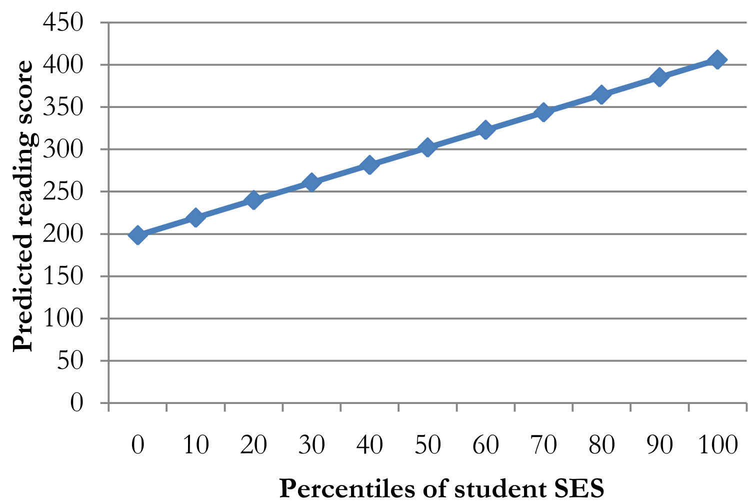


Figure 3.10b: SES gradients in International Comparison

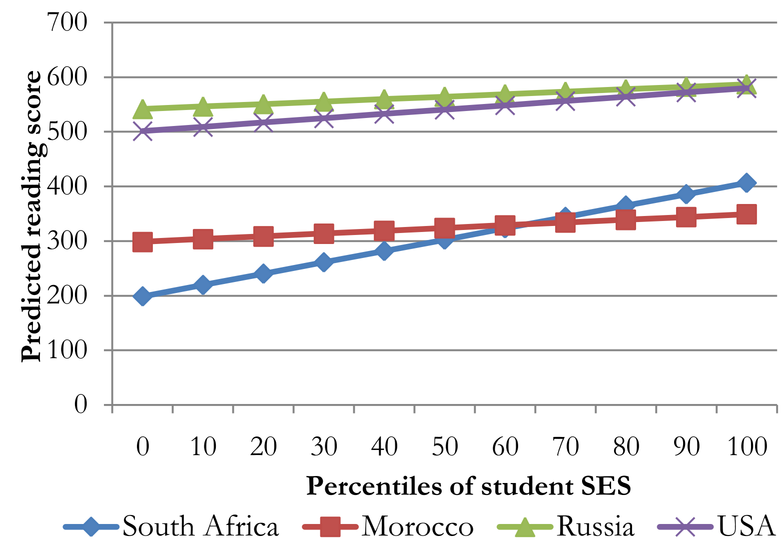


Table 3.3: Estimates and regression statistics for socio-economic gradients by country

	South Africa	Morocco	Russia	USA
Intercept	198.49	298.46	542.08	501.27
Coefficient on SES percentile	2.08	0.51	0.45	0.79
t-statistic	65.34	9.30	14.06	23.30
p-value	0	0	0	0
R-squared	0.2256	0.0259	0.0402	0.0947
Observations	14657	3249	4720	5190

3.4.1) Sensitivity of socio-economic gradients to alternative specifications of SES

In order to gauge the sensitivity of the socio-economic gradients to the measure of SES used, the same procedure of generating linear gradients was applied for Russia, Morocco and South Africa when using the measure of SES derived from parent educational attainment and occupation. Alternative gradients could not be estimated for the USA because no information on parent education or occupation was available for this country. Figure 3.11a shows the gradients based on the original asset-based measure of SES and Figure 3.11b shows the gradients based on the alternative measure of SES. For the sake of comparison, both sets of gradients were calculated using the same sample of students for whom parental occupation information was available, making the gradients and regression statistics different from those in Figure 3.10b and Table 3.3. The changes were most noticeable for South Africa because the sample size was roughly halved due to missing data on parent occupation.

It is clear that the overall picture when comparing the gradients for South Africa, Morocco and Russia is remarkably similar for the two competing measures of SES. For South Africa more of the variation in reading achievement is explained by the asset-based SES index than by the parent education and occupation index. This, combined with the large loss of sample size incurred when using the latter index, means that the asset-based SES index is definitely preferable for analysis on South Africa. However, the parent education and occupation index appears more appropriate for Morocco and Russia. More of the variation in reading achievement amongst Moroccan and Russian students is explained by this measure. The slope coefficients also increase in size when using the parent status index – it doubles for Morocco (from 0.48 to 0.96) and nearly doubles for Russia (from 0.44 to 0.79). Despite this, the slope coefficients remain small in comparison with South Africa.

Figure 3.11a: Gradients using SES index based on household items

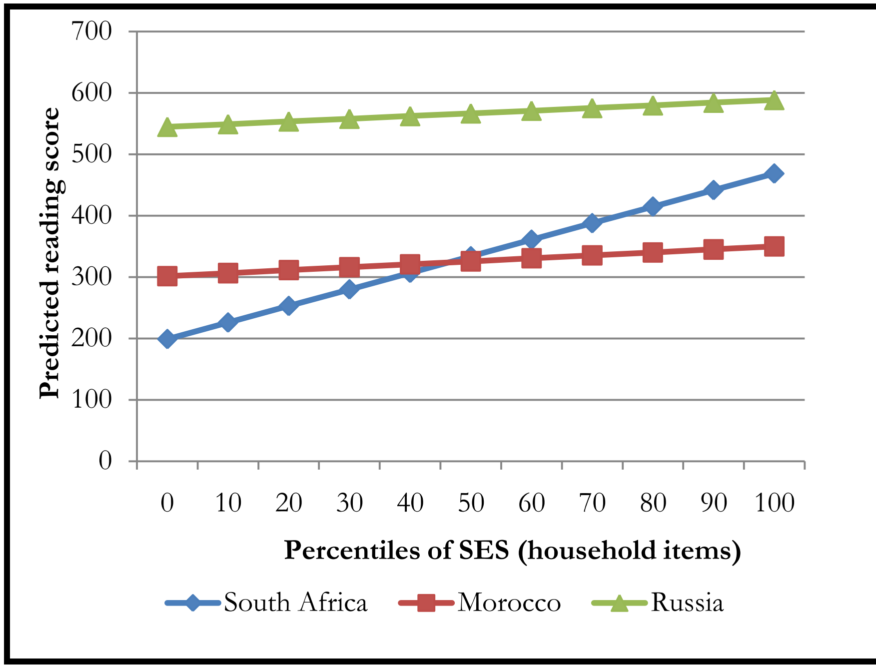


Figure 3.11b: Gradients using SES index based on parent education and occupation

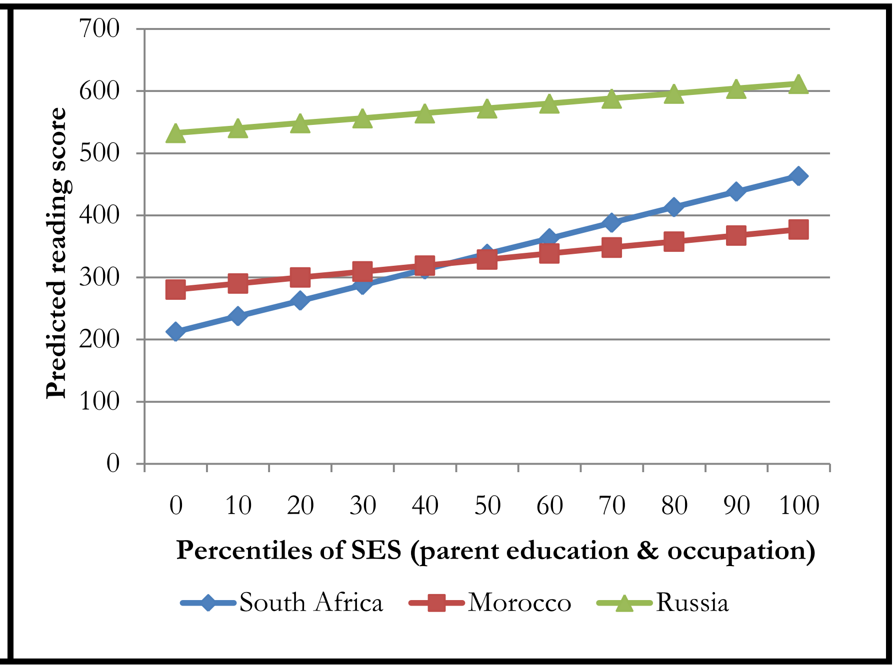
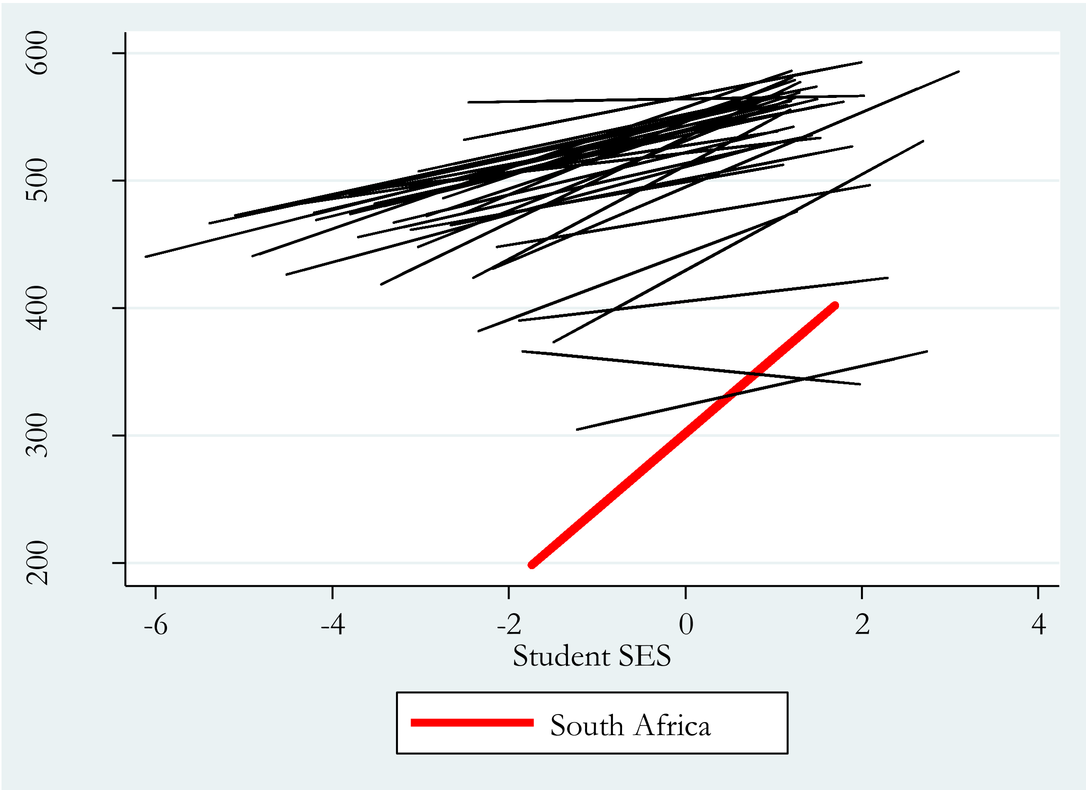


Table 3.4: Estimates and regression statistics for socio-economic gradients by country and alternative measure of SES

	SES based on household items			SES based on parent education & occupation		
	South Africa	**Morocco**	**Russia**	**South Africa**	**Morocco**	**Russia**
Intercept	198.90	301.71	544.72	212.35	280.66	532.78
Coefficient on SES percentile	2.70	0.48	0.44	2.51	0.96	0.79
t-statistic	40.74	7.12	11.9	36.02	13.93	18.99
p-value	0	0	0	0	0	0
R-squared	0.3077	0.0231	0.0389	0.2585	0.0880	0.0998
Observations	6840	4447	2775	6840	4447	2775

The overall pattern thus remains the same irrespective of the measure of SES. The gradients for South Africa and Morocco are much lower than that for Russia, while the slope and strength of the relationship between reading achievement and SES is much greater for South Africa than for the others. Figure 3.12 confirms that South Africa is an outlier when it comes to the level and slope of its socio-economic gradient. The figure depicts socio-economic gradients for a much wider selection of countries in PIRLS.[23] An index for SES was derived for each country by applying PCA to the household items variables. SES was then standardised to have a mean of zero and standard deviation of one within each country. Therefore, the level of affluence at a single point on the x-axis is not comparable across countries.[24] The line for South Africa is at a lower level[25] and is steeper than all the other countries in this sample.

Figure 3.12: Socio-economic gradients for a wide selection of PIRLS countries



[23] Figure 3.12 depicts socio-economic gradients for Austria, Bulgaria, Germany, Hong Kong, Iceland, Iran, Israel, Italy, Latvia, Lithuania, Luxembourg, Moldova, New Zealand, Norway, Romania, Russia, Slovakia, Slovenia, South Africa, Spain, Sweden, Macedonia, England, Scotland, Belgium, Taipei, Denmark, France, Georgia, Qatar, USA, Indonesia and Morocco.

[24] The length of the lines and their position along the horizontal axis do not reflect comparable differences between the countries. In all countries the mean SES is zero. A line which is long below zero and short above zero indicates that the most of the people in that country had most of the household assets. Therefore, those individuals who had very few household assets might be three or even four standard deviations below the mean. Therefore the line length only reflects the skewness of the distribution of SES.

[25] Although the South African line crosses two others, it is certainly the lowest at the 50th percentile and across most of the distribution of SES.

3.4.2) Sensitivity of the South African socio-economic gradient to different datasets

In order to test the reliability of the South African socio-economic gradient the same technique was applied to data from SACMEQ II and the three waves of TIMSS (1995, 1999 and 2002). TIMSS and SACMEQ also include a number of questions regarding household items, making the same analysis possible.[26] The SACMEQ dataset provides a useful link between PIRLS and TIMSS, because SACMEQ tested reading (making it comparable with PIRLS) and mathematics (making it comparable with TIMSS). SES gradients were derived for each survey and for each subject domain. For the sake of comparability across the surveys, both the SES indices and the achievement variables were standardised to have a mean of zero and standard deviation of one. The regression estimates are provided in Table 3.5.

Table 3.5: Regression estimates for socio-economic gradients PIRLS, SACMEQ and TIMSS

Survey	Subject	Regression estimates
PIRLS	Reading	$\hat{Y} = 0.0695 + 0.5169 \times \text{SES}$
SACMEQ II	Reading	$\hat{Y} = 0.0637 + 0.5232 \times \text{SES}$
SACMEQ II	Mathematics	$\hat{Y} = 0.0630 + 0.4428 \times \text{SES}$
TIMSS 1995	Mathematics	$\hat{Y} = 0.1110 + 0.5502 \times \text{SES}$
TIMSS 1995	Science	$\hat{Y} = 0.1190 + 0.5726 \times \text{SES}$
TIMSS 1999	Mathematics	$\hat{Y} = -0.0121 + 0.5283 \times \text{SES}$
TIMSS 1999	Science	$\hat{Y} = -0.0241 + 0.5426 \times \text{SES}$
TIMSS 2002	Mathematics	$\hat{Y} = -0.0067 + 0.4948 \times \text{SES}$
TIMSS 2002	Science	$\hat{Y} = -0.0145 + 0.5085 \times \text{SES}$

The slope coefficients range from 0.44 to 0.57. For the sake of a visual perspective, consider Figures 3.13 and 3.14, which show the reading gradients and the mathematics gradients respectively. What is perhaps most pleasing for the sake of the present analysis of the PIRLS data is how similar the SES gradients are for the two reading surveys. At a first glance it looks as if there is only one gradient presented in Figure 3.13. However, the line for the SACMEQ

[26] Detailed information about SACMEQ and TIMSS surveys and the household items variables in each survey is provided in Appendix D.

reading scores lies virtually on top of the original SES gradient for the PIRLS data. The slope coefficients are very close: 0.5169 for PIRLS and 0.5232 for SACMEQ.

The slopes for the mathematics surveys in Figure 3.14 are fairly similar across the three rounds of TIMSS. The gradient for the SACMEQ data is somewhat flatter however. One possible contributing factor to this result relates to the fact that SACMEQ tested at the sixth grade whereas TIMSS tested grade 8 students. Given that much of the South African school system is seriously under-performing and that much of the variance in educational achievement is explained by SES, one might expect low-SES students to fall further behind with every grade they move through. Low-SES students would then be further behind high-SES students in grade 8 than in grade 6. This would manifest in a steeper SES gradient at the grade 8 level than at the grade 6 level, as is indeed the case in Figure 3.14.

Figure 3.13: South African socio-economic gradients for reading surveys

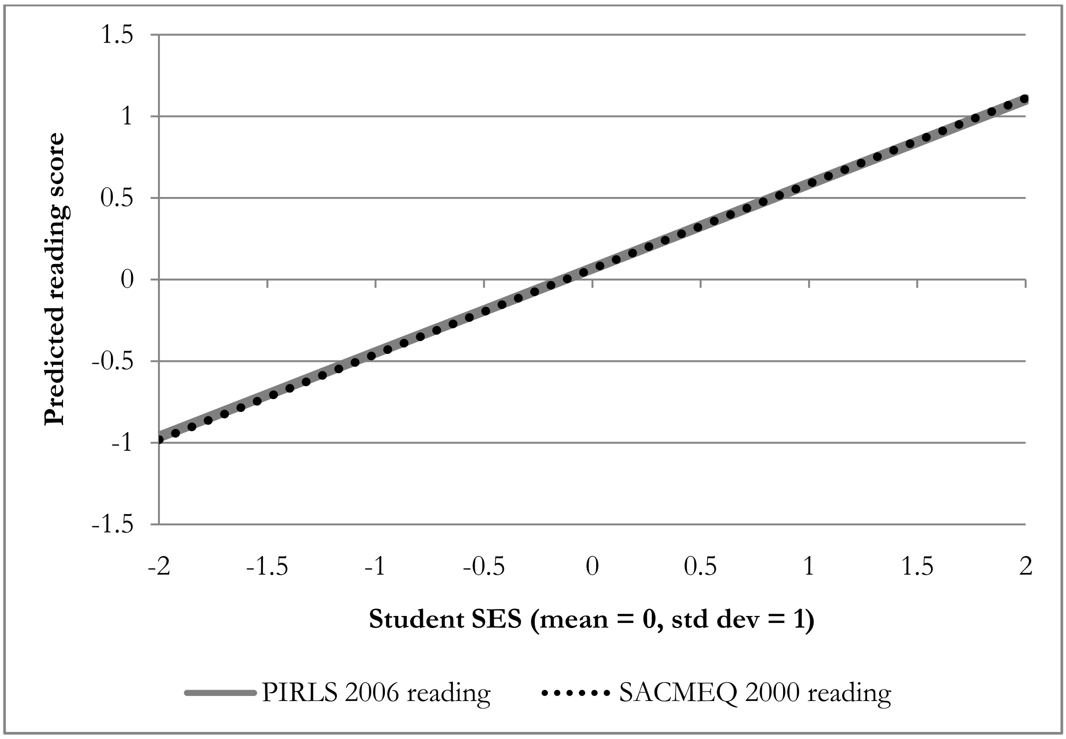
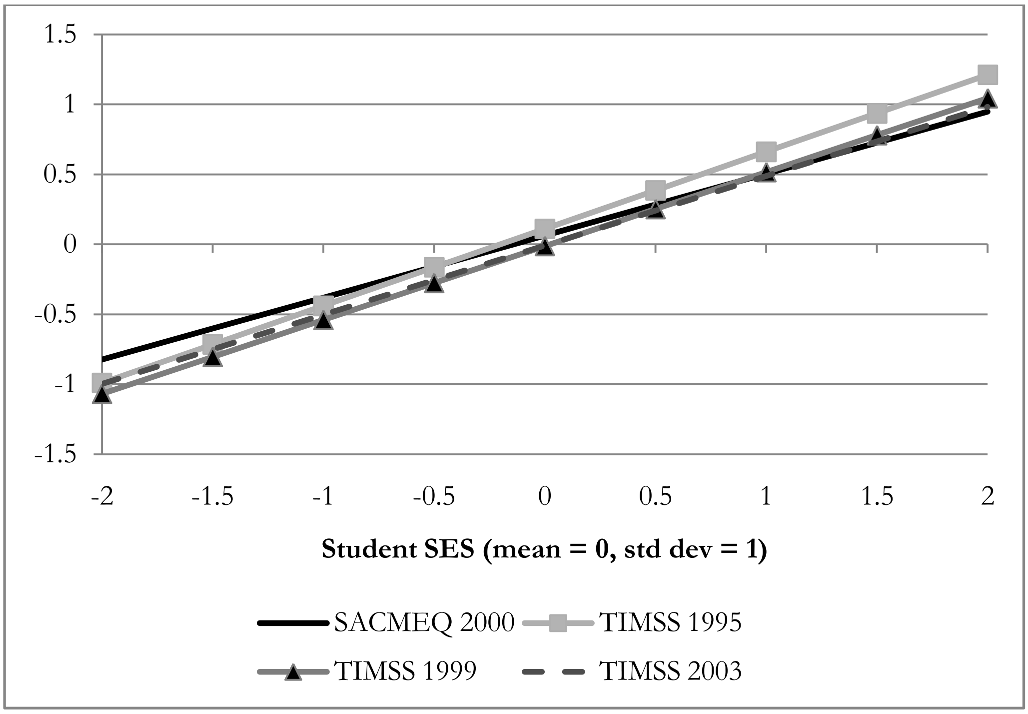


Figure 3.14: South African socio-economic gradients for mathematics surveys



3.4.3) Imputed income gradients

Ross and Zuze (2004) presented socio-economic gradients for the SACMEQ II countries using an SES index based on the household asset variables in SACMEQ. The household assets were the same across all 14 countries, allowing points along the SES scale to be directly comparable across countries. This means that the length of each socio-economic gradient in Ross and Zuze (2004) reflected the level of material inequality in each country.

An attempt to make the level of SES comparable across the countries in PIRLS was made by way of a crude imputation. *Per capita* Gross National Income (GNI) as well as the shares of income held by the poorest 20% and richest 20% of the population for South Africa, Russia, Morocco and the USA in 2006 were retrieved from the World Bank (2009). These statistics are reported in Table 3.6.

Table 3.6: GNI per capita in 2006

	GNI pc ($)	share bottom 20%	share top 20%
Morocco	3890	7	47
Russia	12810	6	39
SA	8960	3	62
USA	44270	5	49

Source: World Bank (2009)

Students in PIRLS were assigned an income based on the percentile of SES (the asset-based index) they fitted into, such that the distribution of income within each country's sample of students was a close match to the proportions in Table 3.6. The log of income was then used to predict reading scores. The regression estimates were then plotted to form imputed income gradients, as shown in the following figure. The corresponding regression statistics are reported in Table 3.7.

Figure 3.15: Imputed income gradients

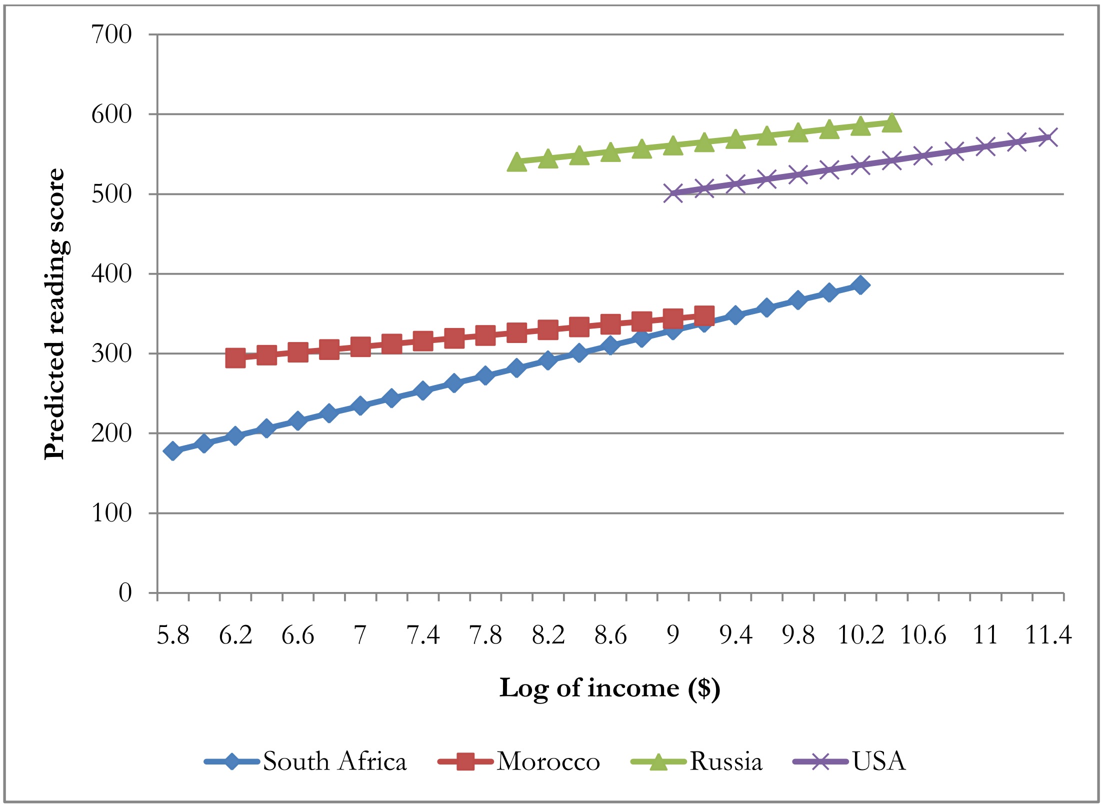


Table 3.7: Estimates and regression statistics for imputed income gradients by country

	South Africa	Morocco	Russia	USA
Intercept	-96.88	185.06	377.26	237.45
Coefficient on SES percentile	47.31	17.65	20.45	29.29
t-statistic	41.51	8.60	12.93	19.93
p-value	0	0	0	0
R-squared	0.2005	0.0281	0.0441	0.0969
Observations	14657	3249	4720	5190

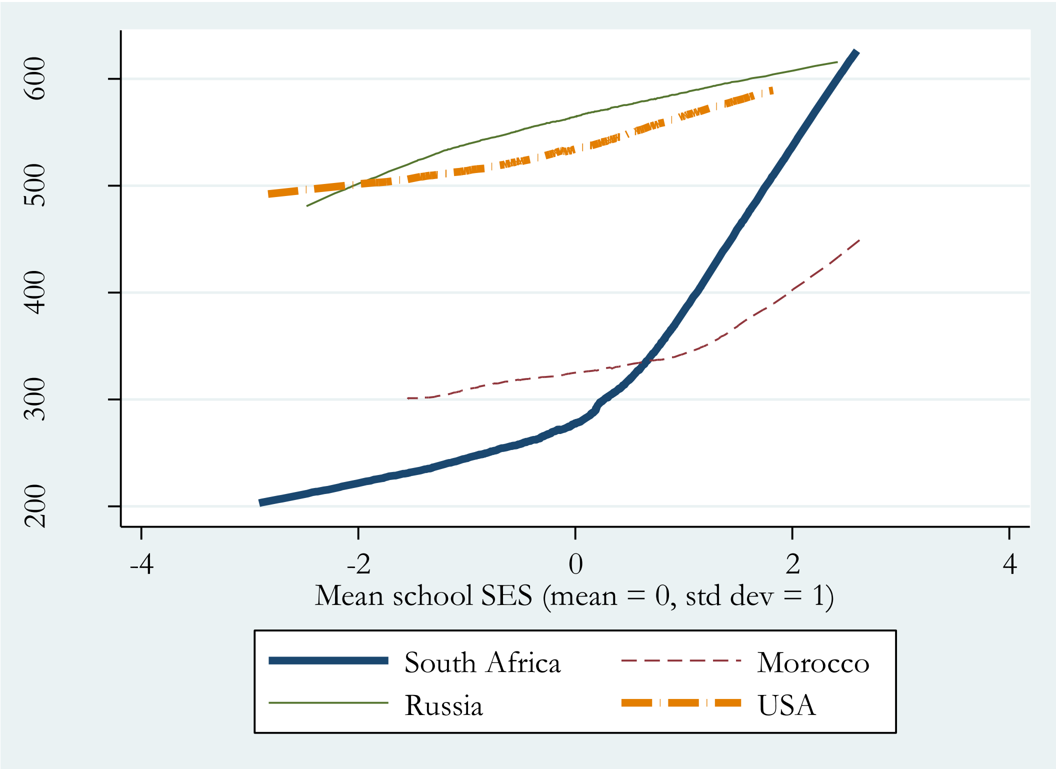
As with the socio-economic gradients presented earlier, the overall pattern remains the same: the level of the lines is lower for South Africa and Morocco, while the slope is greatest for South Africa. In addition, Figure 3.15 shows that South Africa has the longest line, which is a reflection of the wide income inequality that persists in this country. Moreover, one can now say that across most of the distribution, Moroccan students are out-performing South African students at corresponding levels of SES. This would suggest that, although educational achievement is particularly strongly associated with SES in South Africa, this association cannot be solely attributed to SES itself. Rather, there must be other educationally disadvantageous factors that are associated with poverty in South Africa. Thus, a major objective of this thesis is to explore how SES influences educational achievement in South Africa, and to identify specific factors that negatively impact on educational achievement amongst poor children.

3.4.4) Lowess-type gradients

The socio-economic gradients presented up until now are all based on a linear regression relationship. One way to investigate whether the assumption of a linear shape is justified is to use lowess regressions. Lowess regressions do not require a linear or quadratic model specification but carry out locally weighted regressions at each data point and smooth the result through the weighting system. This means that the shape of a lowess curve is determined by the data rather than by the imposition of a model specification.[27] Figure 3.16 graphically presents the lowess regression relationship between reading scores and SES for Russia, Morocco, the USA and South Africa. Note that in this case the dependent variable is the mean reading score within each school and the explanatory variable is the mean SES within each school.

[27] Further explanation of the lowess smoothing methodology is provided in Appendix E.

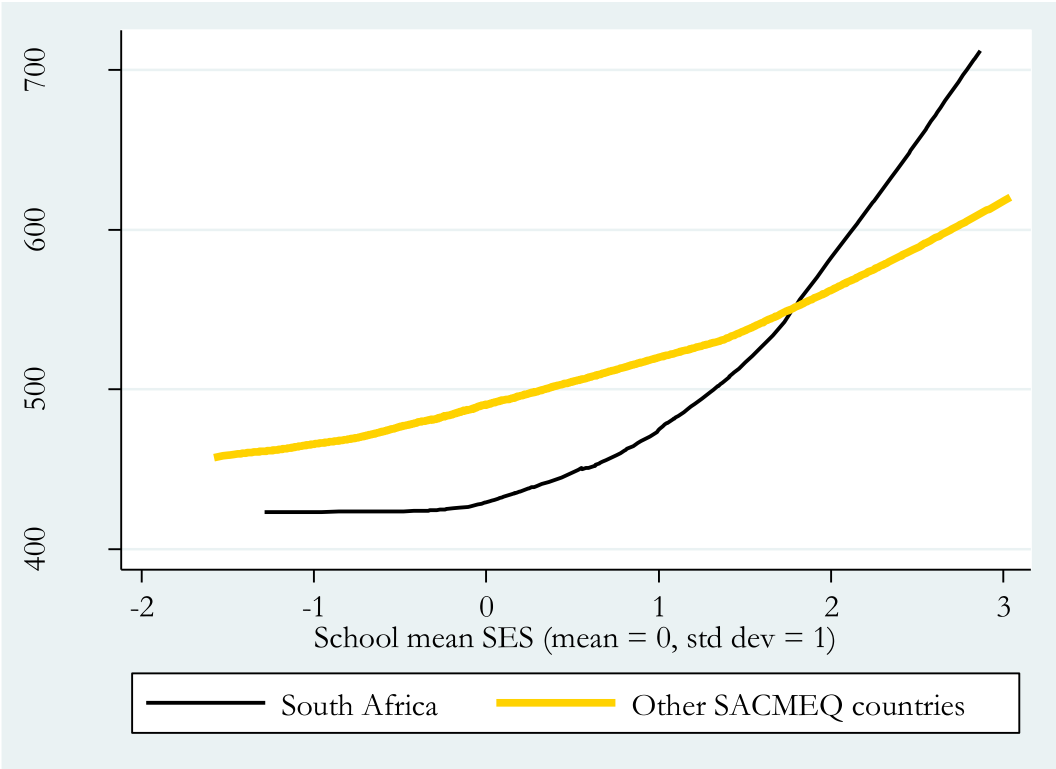
Figure 3.16: Lowess-type gradients by country



As in earlier figures, the lines for Russia and the USA are at a much higher level than those for South Africa and Morocco. The slopes for Russia, Morocco and the USA seem approximately linear. Interestingly though, the relationship between SES and reading performance in South Africa seems to be non-linear and convex. Put differently, the association between reading scores and SES is stronger at higher levels of SES. This warrants further investigation and the inclusion of a squared SES variable in the multivariate analysis to follow.

For the sake of comparison, lowess-type gradients were fitted using the SACMEQ II data. Figure 3.17 shows the lowess gradient for South Africa and a gradient for the other 13 SACMEQ participants combined. The outcome variable in this case is school mean reading score.

Figure 3.17: Lowess-type gradients for South Africa and other SACMEQ countries



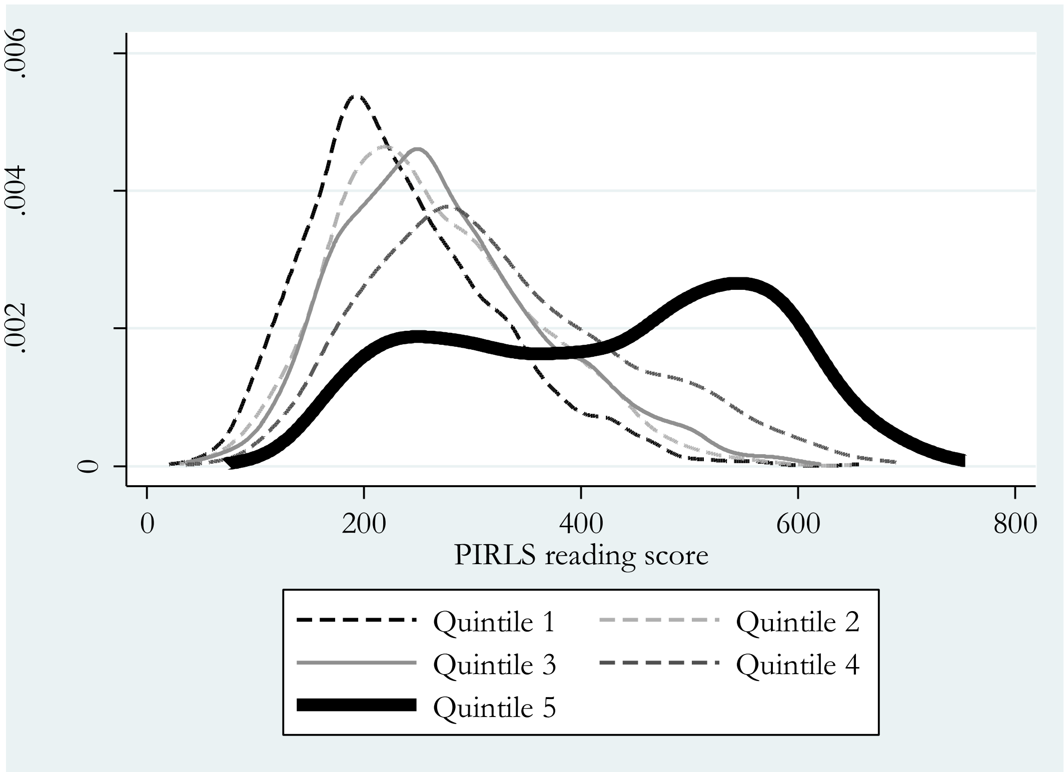
The South African lowess-type gradient confirms the convex shape obtained with the PIRLS data. At the low end of the socio-economic distribution, increases in school mean SES are not associated with significant improvements in reading achievement, while at the higher end increases in school mean SES are associated with large reading gains. Figure 3.17 also confirms what the imputed income gradients suggested, namely that for much of the distribution South Africa is underperforming at given levels of SES. This figure demonstrates that apart from those in more affluent schools, South African children are performing worse than equally poor children in the other African countries in the SACMEQ sample. This piece of evidence certainly warrants an investigation into the channels through which SES affects education in South Africa, as well as into other determinants of schooling outcomes, focusing especially on the poorer section of the school system.[28]

[28] Van der Berg (2007: 857) produced a similar figure, the only difference being that the outcome of interest was mathematics achievement in SACMEQ. The overall picture was hardly different to that obtained in Figure 3.17. The figure from Van der Berg (2007) is reproduced in Chapter 4 as Figure 4.1.

3.4.5) Disaggregating the South African socio-economic gradient

Another way of describing how reading achievement in PIRLS differs amongst South African children on the basis of SES is to show the distribution of reading achievement within each quintile of SES. Figure 3.18 presents Kernel Density curves of reading scores by SES quintile.

Figure 3.18: Kernel Density curves of reading achievement by SES quintile

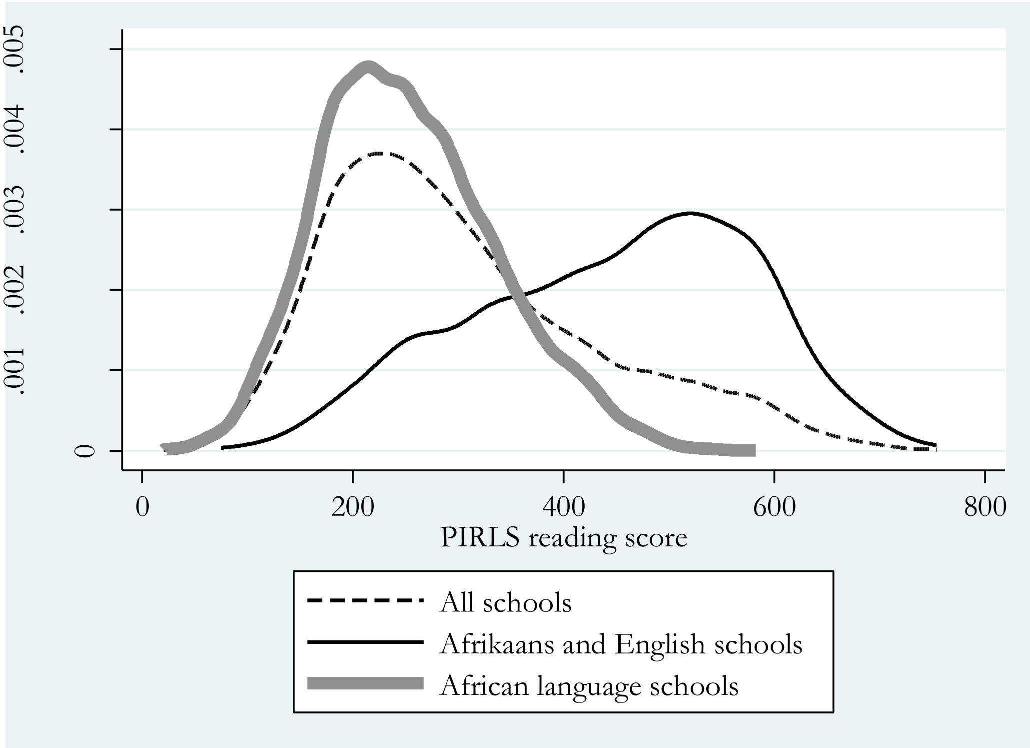


A striking feature of the above figure is that the distributions are remarkably similar across the bottom four quintiles. However, the top quintile has a completely different distribution with a large concentration of students achieving relatively high reading scores. This pattern starkly emphasises the same underlying reality that was evident in the lowess-type gradient for South Africa: the gradient was rather flat for much of the distribution and then very steep at the higher end of the socio-economic spectrum.

This unequal distribution of educational achievement in South Africa has been characterised by several authors as "bimodal" (e.g. Fleisch, 2008; Van der Berg, 2008). This refers to the phenomenon that two separate distributions (corresponding to two differently functioning parts of the school system) are concealed within the overall distribution of achievement in South Africa. According to this distinction, approximately 80-85% of South African students are located within a "sub-system" that can be described as historically disadvantaged and currently poorly functioning. The second "sub-system" consists mainly of historically white and Indian schools and demonstrates much greater functionality. Since the racially separate education departments were done away with, a fair amount of migration out of historically black schools into historically white, coloured and Indian schools has taken place amongst the growing black middle class. However, negligible movement in the opposite direction has occurred with the result that historically black schools have to "contend with both the disadvantages of apartheid as well as the migration of better performing learners..." (Reddy, 2006: xiii) This only perpetuates the so-called bimodality of South Africa's educational achievement.

As Van der Berg (2008: 145) maintains, "separate data generating processes" are operating in each of the two "sub-systems", thus necessitating sensitivity to this underlying structural aspect when analysing educational achievement data for South Africa. In the PIRLS data there is no information on student race or the former racially based education department of schools with which to divide the sample into the two "sub-systems". However, schools had the option of taking the reading test in any of the 11 official languages. Therefore one can be almost certain that schools which took the test in an African language were historically black schools or, in the case of new schools, would have been if they had existed during the former regime. It is likely that some historically black schools would have taken the test in English, making it harder to isolate historically advantaged schools. In order to deal with this, schools that took the test in English but where less than 30% of the students reportedly always spoke English at home were treated as a separate uncertain sub-sample. Under this classification, 9,837 students (265 schools) were in schools that took the test in an African language, 2,623 students (81 schools) were in schools that took the test in Afrikaans or English and where more than 30% of students reportedly always spoke the language of the test at home, and 1,819 students (49 schools) were in schools that took the test in Afrikaans or English but where less than 30% of students always spoke the language of the test at home. Figure 3.19 shows kernel density curves for the African language schools and for the Afrikaans and English language schools as well as a combined curve for all schools.

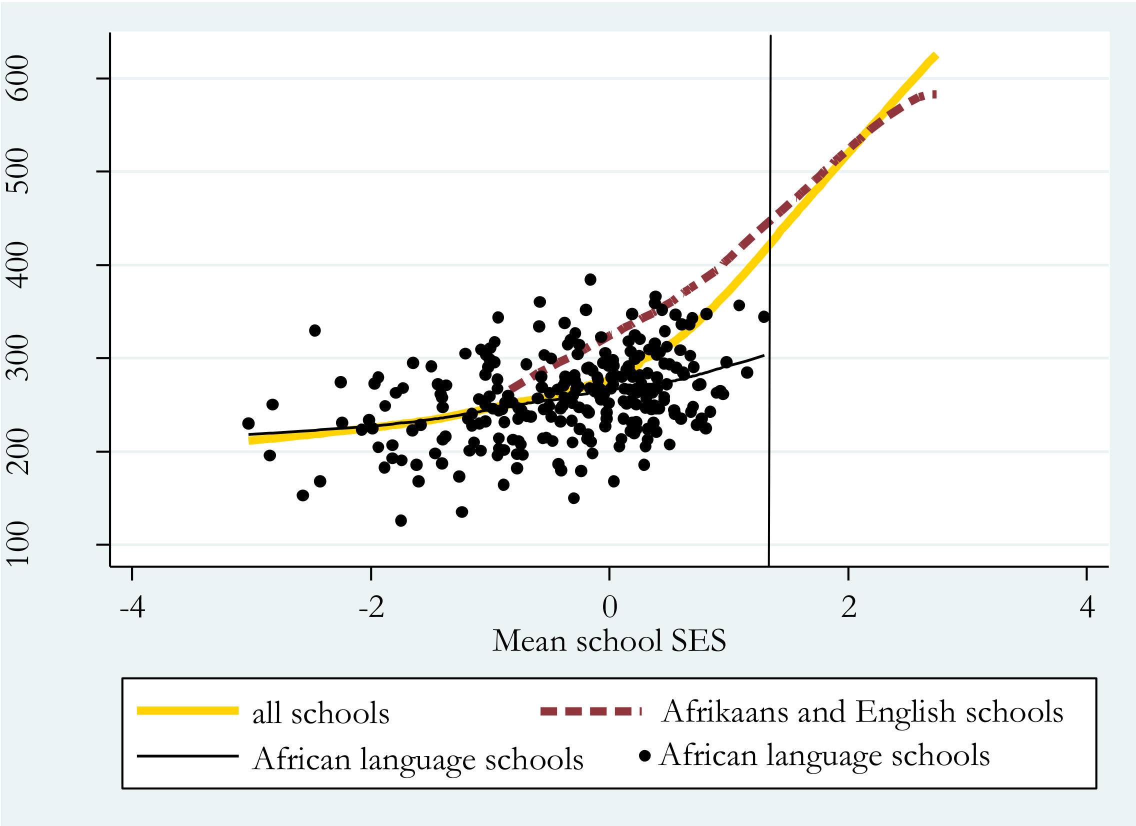
Figure 3.19: Kernel Density curves of reading achievement by language of the test



The kernel density curve for all schools indicates that the distribution of reading achievement was not bimodal, strictly speaking. However, the disaggregated curves demonstrate that two very different distributions are evident and the modes of these two distributions are far apart. The distribution for African language schools lies far to the left indicating a low overall level of achievement and is very concentrated. The Afrikaans / English distribution lies considerably to the right and contains more variation, possibly indicative of several historically disadvantaged schools that have been "mistakenly" included despite the adjustment for the proportion always speaking English at home. The pattern in Figure 3.19 is analogous to that in Figure 3.18 – the distribution for African language schools is very similar to that for the bottom four SES quintiles and the distribution for Afrikaans and English schools is very similar to that for the top SES quintile. This implies that in order to understand the influence of SES on educational achievement in South Africa it may be necessary to recognise that two historically different and persistently differently performing systems are present.

Estimating separate lowess-type gradients for these two sub-systems of schools is very revealing. Figure 3.20 shows that the lowess gradient for African language schools is flat and is driving the flat part of the lowess gradient for the full South African sample. On the other hand, the steep part of the gradient is entirely accounted for by the gradient for Afrikaans and English language schools. Therefore, the real story might not be that SES affects achievement non-linearly *per se*, but that two separate data generating processes are at work, causing the effect of SES to operate differentially in the two historically different parts of the school system.

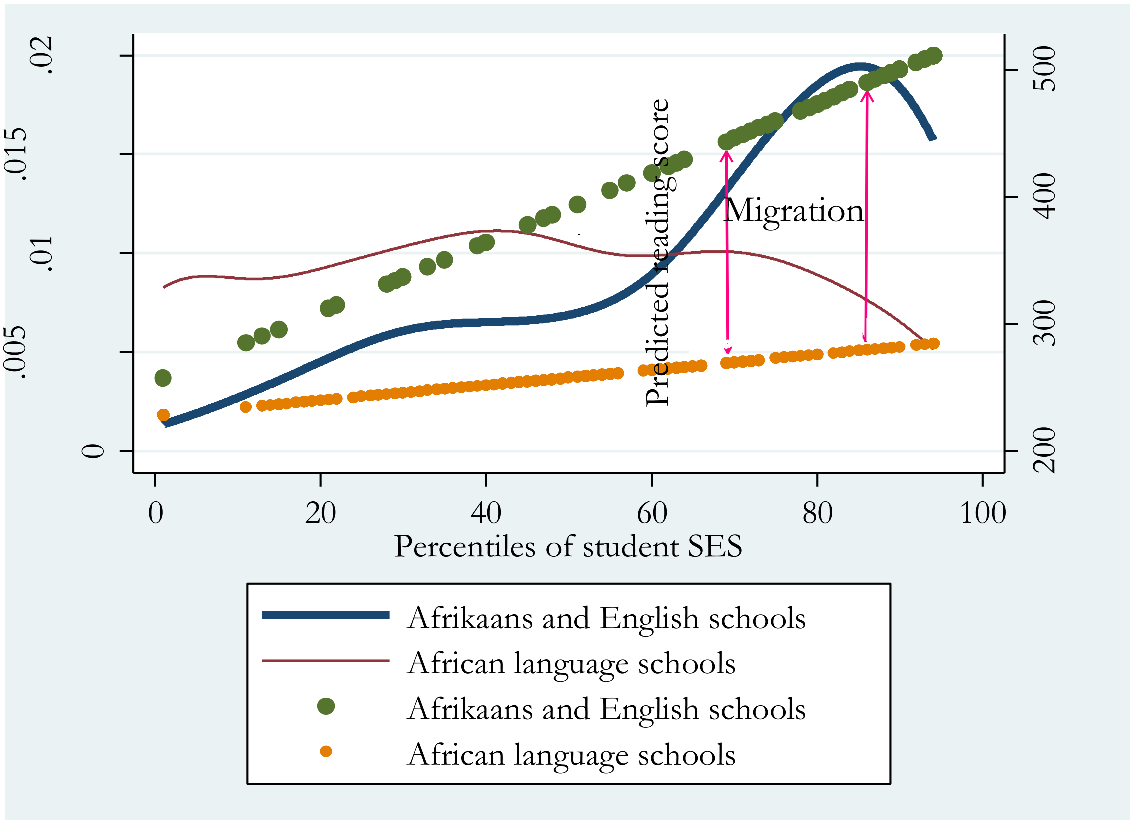
Figure 3.20: Lowess-type gradients by language of the test



Each dot in the scatterplot included in Figure 3.20 represents an African language school. It is striking that there is not a single African language school scoring above the low international benchmark score of 400. Also, there are no African language schools beyond a certain level of mean SES, indicated by the vertical line in the figure. This may relate to the phenomenon that the emerging black middle class has been withdrawing from the historically black school system and migrating to historically white, coloured and Indian schools (Soudien, 2004: 107). Put differently, children in historically (and predominantly still) black schools are performing dismally in general, while those black children who can afford to are exiting the system. Therefore, the way to think about the effect of SES on educational achievement in South Africa may be as follows: home SES is crucial in determining which school system one enters; then for those in the historically black system the chances of achieving high quality educational outcomes are small, regardless of home SES.

Figure 3.21 illustrates the incentive for migration out of the historically black system. The figure shows linear socio-economic gradients for students within African language schools and for students within Afrikaans and English schools. Superimposed on the same figure are kernel density curves to provide a sense of where the bulk of these two groups are populated along the socio-economic spectrum. The pertinent area of comparison between the two gradients is in the middle and high range of SES as this is where significant numbers are present in both school types. It can be seen that for students occupying the same socio-economic position in South African society there is a major advantage associated with being in a historically privileged school. As the arrows in the figure suggest, it makes sense for students who can afford it financially to migrate from the poorly performing system to the well-functioning system.

Figure 3.21: Linear socio-economic gradients by language of the test



Note: The dotted straight lines are the socio-economic gradients and correspond to the vertical axis on the right hand side. The solid lines are kernel density curves and correspond to the vertical axis on the left hand side.

The next sub-section further investigates the role of schools in the relationship between SES and reading achievement in South Africa using two techniques that are designed specifically for such analysis.

3.5) The role of schools in the effect of SES on reading achievement

3.5.1) Intra-class correlation coefficients

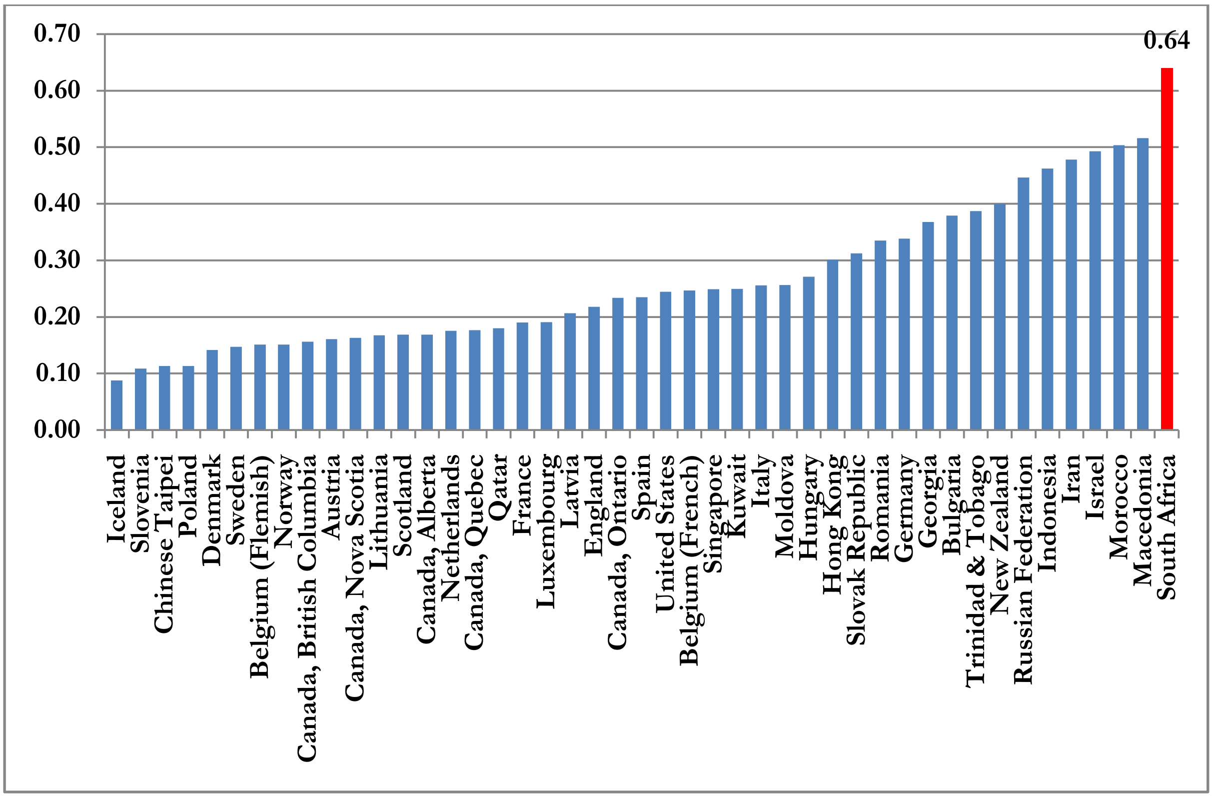
The overall variation in reading scores in South Africa can be divided into variation due to within-school student factors and variation due to differences between schools. The "within-school" variation and "between-school" variation can be derived using Hierarchical Linear Modelling (HLM), which is a technique that analyses student-level variation and school-level variation separately. Section 3.7 explains the methodology of HLM in some detail before going into a detailed multivariate HLM analysis. An HLM model with no explanatory variables (known as a fully unconditional model) separates the "within-school" variation from the "between-school" variation. With this information an intra-class correlation coefficient (*rho*) can be derived according to the following formula:

$$\rho = V(\mu_{0j}) / [V(\mu_{0j}) + V(r_{ij})] \qquad (3.5)$$

where $V(\mu_{0j})$ is the between-school variance and $V(r_{ij})$ is the within-school variance. Thus *rho* is the ratio of between-school variance to overall variance. In a country where each school was identical, *rho* would equal zero. Conversely, if all the variation in reading scores was determined by school-level factors, the *rho* value would be equal to one.

Rho values were generated for each of the participants in PIRLS 2006. Of course the *rho* values say nothing about the impact of SES or any other student or school-level characteristic on reading scores. They only indicate how much of the overall variance in reading scores is attributable to within-school variance and how much to between-school variance. The results are presented in Figure 3.22.

Figure 3.22: Proportion of variation due to differences between schools for PIRLS participants (Rho)



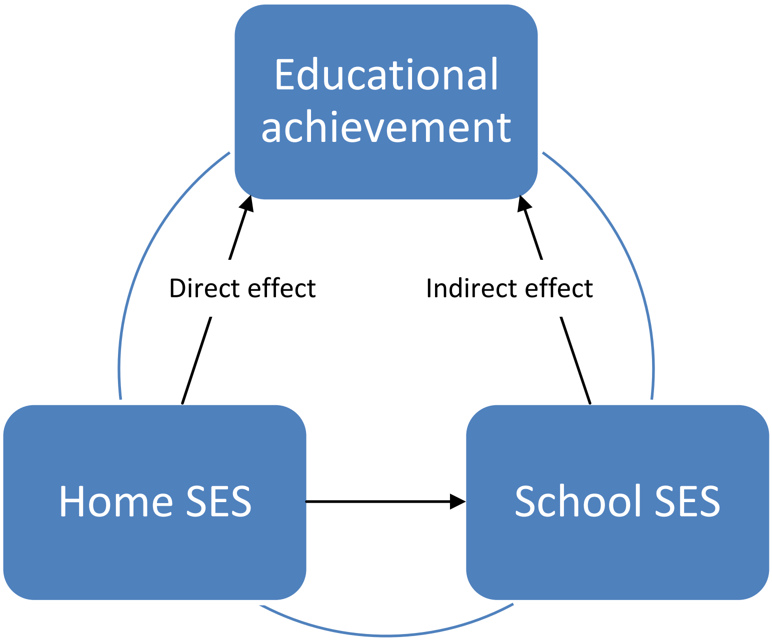
Once again South Africa is an outlier by a considerable distance amongst the PIRLS participants with the highest *Rho* value. This means that between-school variation accounts for a larger proportion of overall variation in South Africa than in any of the other countries. In almost all the countries the majority of the overall variation is attributable to differences between students or "within-school" variation, where innate ability and home SES are among the factors playing a role. In South Africa, however, the majority of variation is due to differences between schools. This is further evidence that variation in school quality is a crucial dimension of reading achievement in South Africa.

3.5.2) Decomposition of direct and indirect effects of SES

Rho values offer no information about which school characteristics contribute to between-school variation. As the present focus is mainly on the impact of SES, a type of decomposition technique was applied in order to investigate the role of schools and school mean SES within the broader impact of SES on reading achievement in South Africa.

The effect of SES on reading achievement can be thought of as consisting of a direct effect and an indirect effect. The direct effect is through home support factors and the indirect effect is through determining the type of school students have access to. The indirect effect therefore includes the impact of the SES of school peers, which the Coleman Report (1966) drew attention to. As was suggested in the previous section, student SES appears to play a major role in allocating students into the two historically different parts of the school system. Once this allocation has taken place the mean school SES affects educational achievement, while individual SES continues to have a direct influence through home support factors. The logic of this is expressed in the schematic diagram below.

Figure 3.23: Direct and indirect effects of SES *on educational achievement*



Fortunately, it is possible to separate out these direct and indirect effects empirically. One can express the correlation coefficient between student socio-economic status (SES) and reading scores ($r_{X,SES}$) as the sum of the normalised regression coefficients of SES ($\beta_{SES,X}$) and School SES ($\beta_{S\_SES,X}$) when included in a multiple regression predicting the reading score (X), each multiplied by the correlation between itself and SES. Of course the correlation between SES and itself is simply 1. Formally, this is expressed as follows:

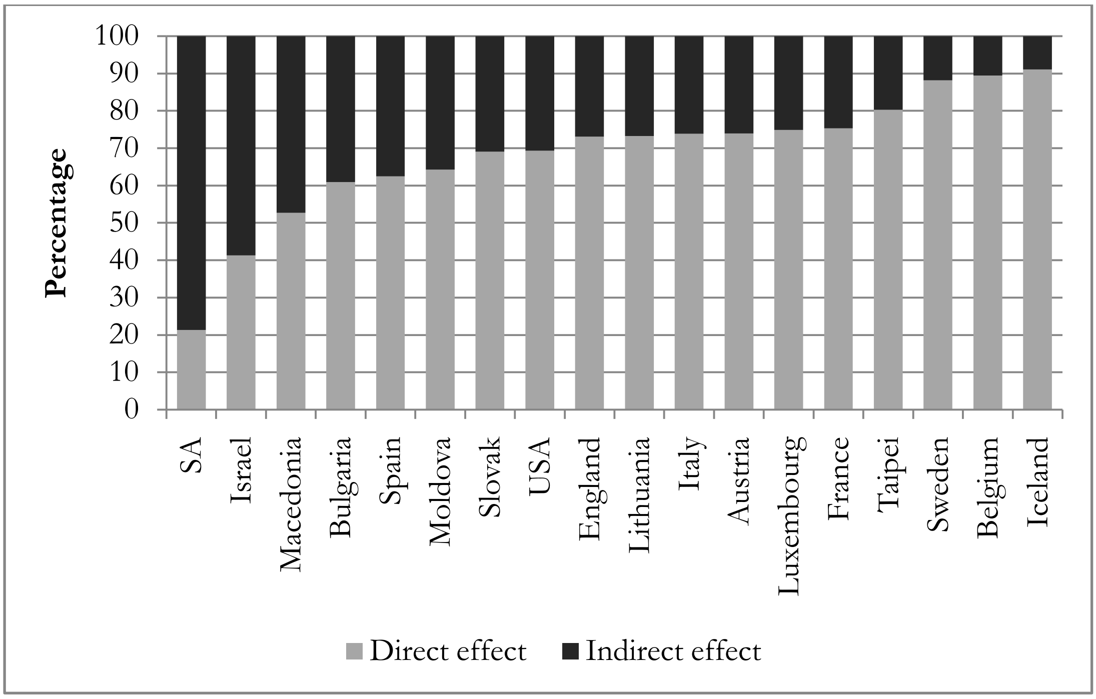
$$r_{X,SES} = \beta_{\text{SES,X}} + r_{SES,S\_SES} * \beta_{\text{S\_SES,X}} \quad (3.6)$$

[29]

Correlation = direct effect + indirect effect

The actual values for the various coefficients in the equation above are easy to obtain using statistical software. Substituting these values into the equation for South Africa and solving it yields a direct effect of 21.34% and an indirect effect of 78.66%. This means that 78.66% of the (sizeable) correlation between student SES and reading achievement occurs indirectly via the mean SES of the school to which students gain access. Only 21.34% of the correlation is accounted for by direct effects including the various aspects of home support. The significance of this result, once again, is more fully comprehended in comparison with other countries. The same decomposition was applied to a selection of countries in PIRLS 2006. Figure 3.24 reports the sizes of the direct and indirect effects of SES in these countries.

Figure 3.24: Decomposition of direct and indirect effect of SES by country



South Africa is again the exception with the largest indirect effect. More than in any of the other countries in this sample, the effect of SES operates through selection into schools where the mean SES of the school then predicts educational achievement. This is an important insight into

[29] This decomposition technique is appropriated from Bowles and Gintis (2002b), who applied it to estimating the direct and indirect effects of parental income on the future income of a child.

the critical role that selection into differently performing sub-sectors of the South African school system plays in the way that SES affects educational outcomes.

3.6) Multivariate analysis of South African achievement in PIRLS 2006

This chapter has already demonstrated that SES (both that of individuals and of the schools they attend) has a particularly strong impact on educational achievement in South Africa. By extending this analysis into a multivariate framework, this section explores the influence of SES conditional upon numerous other influences on reading achievement. Given a variety of factors, what is the importance of SES in determining reading achievement? Moreover, a multivariate analysis also has potential to provide answers to the converse question: after the influence of SES has been controlled for, are any teacher or school characteristics significantly associated with reading achievement? This is perhaps the more relevant question for education policy.

3.6.1) Education Production Functions: some methodological considerations

Before considering any multivariate results, it is worth noting some of the theoretical motivation underpinning education production functions as well as some of the technical difficulties that often arise in such analyses. Much of this discussion is based on Glewwe (2002), who provides an excellent review of education production functions and the associated literature. The basic education production function models cognitive skills as a function of an individual's personal "learning efficiency", school quality and years of schooling. Formally, this can be expressed as follows:

$$A_i = E.f(Q).g(S_i) \qquad (3.7)$$

where A_i is cognitive skill in year *i*, *E* is the individual's "learning efficiency", *Q* is school quality, and S_i is years of schooling up until year *i*. Of course *f* and *g* are increasing functions of *Q* and *S*. The learning efficiency of a student (*E*) comprises a variety of factors. These include innate ability, motivation and aspects of the home environment that affect learning, such as parental education.

In PIRLS, testing was done on South African students in the fifth year of schooling. Therefore, years of schooling (S_i) is constant across all individuals in the sample. Adapting equation (3.7) to model cognitive skills amongst fifth graders yields equation (3.8) below.

$$A_5 = E.f(Q) \qquad (3.8)$$

As an aside, it is worth noting that cognitive skill attained by the fifth grade can be expected to influence an individual's ultimate schooling attainment (S_z). Learning efficiency (*E*) will continue to influence progress through school. It is likely that SES also has an effect on attainment separate from its effect via learning efficiency. In addition, school quality will continue to have an effect on progress through school $- h(Q_{5+n})$, where n = z - 5. Thus equation (3.9):

$$S_z = f(A_5).E.g(SES).h(Q_{5+n}) \qquad (3.9)$$

The relationship expressed in equation (3.9) has important implications for economic mobility due to the strong links between school attainment and labour market performance. The relative strengths of *f*, *g* and *h* will determine the point at which interventions will be most effective. This issue will be investigated in Chapter 5, where the association of achievement at grade 8 with achievement in matric (grade 12) is analysed. For the present analysis, however, the focus is on explaining the level of reading achievement amongst 5th grade students, as expressed in equation (3.8), which can be rewritten in linear functional form as follows:

$$A_5 = \beta_0 + \beta_1 E + \beta_2 Q + e \qquad (3.10)$$

The β coefficients will be estimated using regression analysis. The error term (*e*) captures measurement error in the dependent variable and the explanatory variables as well as variation that is not captured due to omitted variables. As mentioned, "learning efficiency" reflects numerous factors. Thus one can decompose *E* into separate components as follows:

$$A_5 = \beta_0 + \alpha_1 E_1 + \alpha_2 E_2 + ... + \alpha_m E_m + \beta_2 Q + e \qquad (3.11)$$

The α coefficients are parameters to be estimated for various aspects of a student's "learning efficiency", such as parental education, the availability of help with homework at home, SES, etc. In the PIRLS dataset, the variables captured by the student questionnaire and the home questionnaire (completed by parents) contain suitable indicators of "learning efficiency." Similarly, it is possible to decompose school quality (*Q*) into separate components, like the combined SES of each school, aspects of teacher quality and the resource base of schools. This yields equation (3.12).

$$A_5 = \beta_0 + \alpha_1 E_1 + \alpha_2 E_2 + ... + \alpha_m E_m + \tau_1 Q_1 + \tau_2 Q_2 + ... + \tau_n Q_n + e \qquad (3.12)$$

The estimates on these school characteristics (τ's) are useful for policy purposes. However, having said this, one does need to exercise caution in the interpretation of education production function estimates because there are numerous associated technical issues that can lead to biased estimates. Glewwe (2002) offers a particularly rich, rigorous and somewhat unforgiving appraisal of these challenges.

A first issue in education production functions that often plagues developing country analyses is sample selection bias. In countries where non-enrolment is substantial, any sample of students will not be random due to the fact that only school-going children are selected. Fortunately this problem does not come into play much in the South African case due to the country's high rate of enrolment.

Another problem is measurement error in the variables. This may be random or systematic – the former being largely unavoidable. For example, there is likely to be a degree of measurement error in the reading score in PIRLS – this is obvious when one considers that a student would be unlikely to achieve the exact same score if she were to be tested on two separate occasions. Greater caution is required when it is suspected that there is a degree of systematic measurement error present for a particular variable. One case of this is when respondents may have an incentive to answer in a certain way. An example in PIRLS is a question to teachers regarding the proportion of school hours that they spend teaching. It seems plausible to expect that respondents may tend to overestimate this proportion, resulting in an underestimated τ coefficient on this variable.

A more troubling issue is that of unobserved characteristics affecting student "learning efficiency" or school quality. A commonly unobserved aspect of "learning efficiency" is innate ability. By the nature of many surveys such as PIRLS it is often not possible to capture a measure of innate ability. Even when this is attempted it is not without problems. As Glewwe (2002: 442) observes, most tests of innate ability such as IQ tests tend to reflect environmental factors as well as innate ability. A consequence of unobserved aspects of student "learning efficiency" is that the estimated impacts of observed aspects of "learning efficiency" may be biased. There are many other hard-to-observe aspects of learning efficiency relating to child and parent motivation and other characteristics of the home environment. One way to address the problem of unobserved characteristics is to test students at two points in time and then to estimate a value-added model. This is done by either making the gain score the dependent variable or including the first score as one of the explanatory variables. The idea is that the influences of innate ability and other unobservables that remain stable over time are already contained in the first score and will therefore allow unbiased estimates to be obtained. It is certainly advantageous if data have a pre-score, although it does add to the complexity of survey design and can introduce other technical issues. Measurement error will be present in both the pre-score and the post-score, thus worsening the signal-to-noise ratio in the outcome of interest. PIRLS does not contain any pre-score, although in chapters 4 and 5 analysis is presented where the data allow for the inclusion of a pre-score.

Similarly, there are many aspects of school quality that are hard to observe, including teacher effort, principal leadership and managerial skill. When such aspects of school quality are omitted from the analysis the estimated impacts of observed characteristics are likely to be upwardly biased, because the observed aspects tend to be correlated with unobserved aspects. This relates to the observation that "good schools are often good in many ways" (Glewwe, 2002: 443). Thus observed characteristics may to some extent be acting as a more general indicator of school quality.

Another source of biased estimates that Glewwe (2002: 443) considers is the possibility that school quality is to some extent endogenous. This occurs when aspects of individual learning efficiency influence school quality. For example, it is well known that high SES parents tend to get more involved in school affairs, such as fund-raising, holding school staff accountable and even shaping key areas of school policy. Therefore an affluent parent body is likely to have a positive effect on school development and quality. In such a case, the estimated impacts of school characteristics are likely to be overestimated. Conversely, underestimation can also result from endogenous school quality, for example, if government provides additional resources or support to schools with particular unfavourable characteristics, like a low SES student body or deep rural location. In this case the observed characteristic is negatively correlated with an unobserved characteristic, leading to underestimation. Ultimately, sound education production function analysis will recognise when the possibility of bias is present and not rush into bold conclusions in such cases. In response to these technical challenges associated with education production functions Glewwe makes some noteworthy conclusions and recommendations.

> "In summary, uncritical application of OLS regressions can lead to biased estimates of the impact of school quality on learning. Some problems underestimate the impacts, others overestimate them, and still others could go either way. These difficulties are so daunting that some economists doubt that they can be overcome." (Glewwe, 2002: 444)

While this may sound rather severe, the point to be highlighted is that estimates achieved using education production function techniques should be regarded as suggestive rather than definitive, as Glewwe (2002: 476) goes on to advise. He recommends an approach that sets out to gather as much evidence as possible and then make an overall judgement based on a number of estimations of production functions:

> "[If] a large number of good conventional [education production function] studies show that a specific school characteristic increases learning, there is a good chance that these studies are detecting a strong causal relationship, and policies could be based on such findings (the alternative being choosing policies without any evidence whatsoever)." Glewwe (2002: 450)

This is what motivates the approach taken in the rest of this chapter. In the preceding sections various methods were applied in order to gather information about the impact of SES on educational achievement. The multivariate analysis follows the same pattern. Initially, a simple OLS model is built by looking at the effects of student, home, teacher and school characteristics separately and then together in the full model. Thereafter, the South African sample in PIRLS is split into the two historically different school systems in order to identify the effects of the various characteristics within different parts of the school system. In Section 3.6.4, HLM is applied, first for the full sample and then for the two sub-sections of the South African school system. The HLM method is used in recognition of the critique that this technique may be more appropriate than OLS modelling for data that has a nested structure – in this case students are nested within schools. Findings based on this spectrum of models will not be regarded as definitive. However, consistent results may indicate that a fairly reliable message is emerging.

3.6.2) Multivariate analysis using OLS regression

The dependent variable in all the following survey regression[30] models is reading score according to the PIRLS scale where the international mean and standard deviation are 500 and 100 respectively. Four categories of explanatory variables were included in the models corresponding to the various survey instruments administered in PIRLS. There are student-level variables (where the respondents were students), home-level variables (where the questionnaire was completed at home), teacher-level variables (where the respondents were teachers) and school-level variables (where the respondent was the school principal when possible).[31] Applying the theoretical framework discussed in Section 3.6.1, the student-level and home-level variables can be considered to be aspects of a child's "learning efficiency", while the teacher and school-level variables can be considered aspects of school quality.

3.6.2.1) Models for the full South African sample

The OLS regression models for the South African sample in PIRLS are presented in Table 3.8. Models [1] and [2] predict reading achievement solely by SES. Models [3] to [6] examine specific groups of variables corresponding to the various questionnaires separately while conditioning only on SES, age and gender. In model [7] the student, home, teacher and school level variables are combined to form the full model. With the exception of models [1] and [2], separate dummy variables for each province were included but, for the sake of convenience, are not reported. The best performing province was the Western Cape with an average score of 405 while the lowest achieving province was the Eastern Cape with an average score of 245. A box plot of reading achievement by province is provided below.

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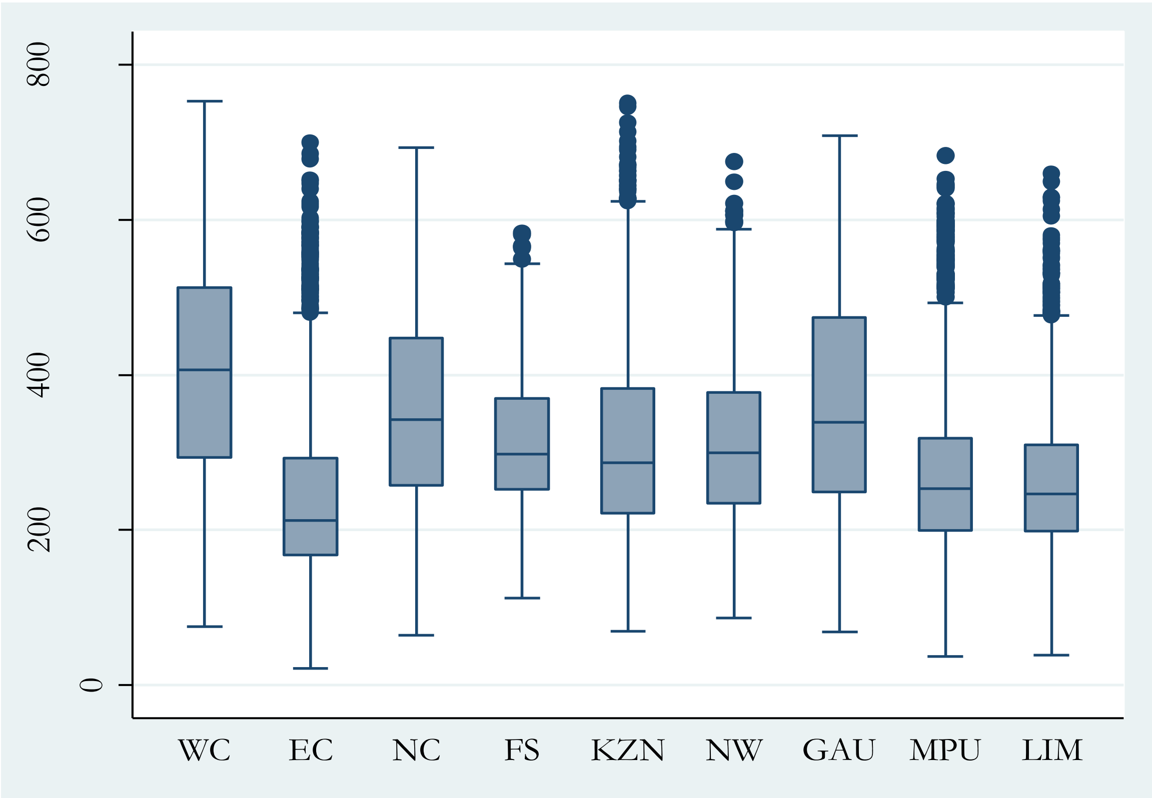
[30] The following survey design variables were used: The stratum variable was province (of which there were 9), the Primary Sampling Unit (PSU) variable was schools (of which there were 397) and the person weight was "totwgt" as provided in the PIRLS data.

[31] All the variables used in the multivariate analysis are described in Appendix F.

Figure 3.25: Box plot of reading achievement in PIRLS by province



Model [1] is the basic socio-economic gradient as presented in earlier sections, although in this instance it is measured in standard deviations rather than percentiles. Thus a one standard deviation increase in SES is associated with an increase in the predicted reading score of 59.53 points, which is just over half a standard deviation.[32] The square of SES is included in Model [2] to allow a quadratic specification. This step was partly motivated by the lowess-type gradients presented earlier, which suggested that the relationship between SES and reading achievement was non-linear. Indeed the coefficient on SES squared is large and statistically significant. It is helpful to graph the results of Model [2] in order to ease interpretation of the coefficients on SES and SES squared. This is presented in Figure 3.26. It is evident from the curve that the change in reading achievement associated with changes in SES is greater at higher levels of SES.

[32] Note that the standard deviation on the international sample was 100 while a standard deviation within the South African sample was of a similar size at 114.7.

Table 3.8: OLS models for the full sample of South African students in PIRLS

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
<u>Student-level variables</u>							
SES	59.53***	-22.37**	-28.62***	-8.46	-12.36~	-12.88*	-2.35
	(4.52)	(7.76)	(6.44)	(5.69)	(6.43)	(5.85)	(3.95)
SES squared		24.81***	19.79***	12.94***	17.01***	12.14***	3.28**
		(2.94)	(2.19)	(1.87)	(2.21)	(1.81)	(1.16)
Under 11			-45.02***	-41.73***	-50.30***	-33.85***	-26.81***
			(3.27)	(2.93)	(3.61)	(2.80)	(2.55)
Over 11			-54.23***	-55.64***	-58.28***	-40.24***	-33.83***
			(5.90)	(5.24)	(6.66)	(5.07)	(4.55)
Female			22.52***	27.15***	27.44***	28.04***	27.13***
			(2.53)	(2.36)	(2.80)	(2.14)	(1.82)
Speak language of test			40.66***				33.38***
			(4.25)				(3.87)
Homework more			22.46***				15.49***
			(3.82)				(2.88)
Homework less			30.73***				12.96**
			(5.84)				(4.27)
Help unnecessary			41.90***				16.66***
			(4.84)				(3.29)
Help from parent			29.36***				9.34***
			(3.83)				(2.63)
Feel safe at school			22.71***				18.67***
			(3.33)				(2.40)
Visit library weekly			16.82***				
			(5.06)				
Visit library sometimes			1.68				
			(4.00)				
More than 10 books			23.07***				
			(4.84)				

Table 3.8 (continued)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Home-level variables							
Full-time job				39.78***			18.64***
				(3.49)			(2.36)
Early literacy: high				14.49***			13.86***
				(4.20)			(3.51)
Early literacy: medium				3.86			6.14~
				(3.74)			(3.42)
Parent matric only				6.19			1.74
				(4.81)			(4.13)
Parent beyond matric				92.70***			38.90***
				(9.71)			(7.06)
Teacher-level variables							
Class size					-3.429***		-1.375*
					(0.970)		(0.600)
Class size squared					0.022**		0.010*
					(0.008)		(0.005)
Teacher experience 4 to 7					-12.46		-18.33
					(16.28)		(12.45)
Teacher experience 8 to 12					-27.41~		-13.97
					(14.07)		(11.36)
Teacher experience 13 to 19					-30.43*		-21.66*
					(12.98)		(10.20)
Teacher experience 20 plus					-14.40		-23.75*
					(13.88)		(10.32)
Teacher has degree					24.82~		
					(13.88)		
Time spent teaching > 50%					20.36~		
					(10.66)		
School-level variables							
Afrikaans						107.93***	74.48***
						(14.29)	(9.52)
English						73.02***	30.13**
						(12.07)	(9.50)

Table 3.8 (continued)

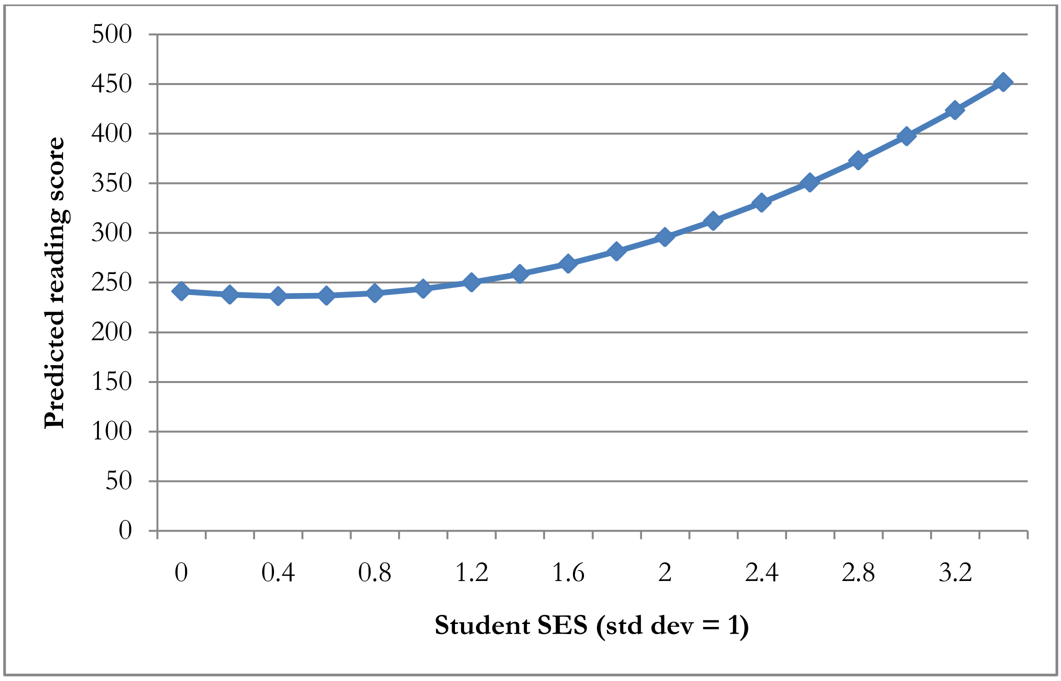
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Rural						-40.58***	-18.13*
						(10.20)	(8.54)
Absenteeism: moderate						-37.48**	-10.03
						(13.43)	(8.30)
Absenteeism: severe						-60.88***	-15.41~
						(12.47)	(7.90)
LTSM shortage: moderate						-9.95	
						(8.74)	
LTSM shortage: severe						-6.43	
						(9.19)	
Infrastructure shortage: moderate						-14.50	
						(8.90)	
Infrastructure shortage: severe						-20.52*	
						(9.52)	
School mean SES							-39.17***
							(10.20)
School mean SES squared							12.37***
							(1.89)
Constant	199.76***	241.29***	172.57***	198.38***	348.10***	315.07***	258.95***
	(5.49)	(5.41)	(9.56)	(8.70)	(28.74)	(17.77)	(24.12)
R-squared	0.2226	0.2645	0.4641	0.4909	0.4321	0.5288	0.6483
N	14279	14279	14279	14279	13342	14279	13342

Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

Regressions [3] to [7] included dummy variables for the provinces but the coefficients on these are not reported in the table. Also, dummy variables controlling for non-response were included for the following characteristics: speaking the language of the test at home, frequency of homework, availability of help with homework, feeling safe at school, number of books in the student's home, frequency of visits to a library, early home literacy activities, teacher experience, teacher degree, time spent teaching, urbanicity of school, absenteeism at schools and shortages of LTSM and infrastructure. Table A.7 in Appendix G reports the complete model statistics with the coefficients on all these additional variables.

Figure 3.26: Quadratic socio-economic gradient based on Model [2]



Model [3] adds a selection of student level variables that proved to be significantly associated with reading achievement, prior to conditioning on any home, teacher or school characteristics. The inclusion of the student-level variables increased the proportion of the variance in reading achievement explained from about 26% to 46%. Strong negative effects on reading achievement were found for those students either above or below the average age of 11. This pattern was consistent across all the models. Another feature of all the models was an advantage for female students ranging from 22 points to about 28 points. Students who spoke the language of the test at home performed considerably better than those who did not. This advantage was just over 40 points in Model [3] and slightly smaller when controlling for home, teacher and school characteristics in Model [7].

Students who reported receiving homework at least once a week or less than once a week did better than those who reported never receiving homework. However, no significant difference in achievement was evident between those who reported receiving homework at least once a week and those receiving homework less than once a week. The question to students about frequency of homework is an attempt to gather information about the school. There were 5 categories of answers to choose from. A new variable for the modal answer in each school was generated. Table 3.9 reports the number of schools with each modal answer and shows the average of each school's mean reading score for each category. The mean student SES in each school is also provided in the table. In 118 schools the modal answer was "never receives homework". The average performance of this group of schools was considerably lower than the other groups, as the table shows. Yet there does not appear to be any further improvement associated with reportedly receiving homework more often. The low performance of students reporting very frequent homework, however, casts doubt on the reliability of these responses, which probably suffered from substantial overestimation.

Table 3.9: Mean reading achievement by frequency of receiving homework at school level

Mode in school	Mean reading	Std dev	School SES	Frequency
Never	260.71	69.00	2.61	118
less than once a week	386.45	135.00	3.47	20
Once or twice a week	340.03	115.66	3.38	73
3 or 4 times a week	312.12	99.72	3.15	26
Every day	296.39	81.47	3.14	156
Total	299.41	95.81	3.04	393

Two further points should be made about Table 3.9. Firstly, the categories of modes derived for the table provide a rather crude representation of reality. For example, it is unlikely that students in all 118 schools for whom the mode was "never" truly never received homework. Nevertheless, it is probably true that, for the most part, these 118 schools gave homework less regularly than the other schools and that this is reflected in the clearly weaker student performance. Secondly, the weaker performance of this group of schools cannot be fully attributed to the frequency of giving homework. The actual size of this effect is probably more in line with the estimates presented in Model [7], which are conditional upon numerous other characteristics. As Table 3.9 demonstrates, the schools in which the mode for frequency of homework was "never" were also poorer on average than the other groups. Thus SES is probably driving much of the difference in reading achievement between the groups in the table. The significance of this table therefore lies in its ability to indicate the type of school functionality issues that are pervasive in the less well-performing and poorer section of the South African school system.

When it came to availability of parental help with homework, the predicted reading score was highest for students who felt that they did not need help with homework. This probably reflects the relative strength of these students. Amongst those who did feel that they needed help, those who received help from parents achieved better than those for whom no parental help was available. The magnitude of this effect declined somewhat when home, teacher and school characteristics were added yet remained statistically significant. Students who estimated that they had more than ten books at home had an advantage of about 23 points, according to Model [3]. However, this effect became insignificant with the inclusion of the other home-level variables. Another consistent pattern throughout the models was that students who felt safe at school performed roughly 20 points better than those who felt unsafe. Although this variable originates from the student questionnaire, it is probably capturing an important component of school functionality. Students that visited a library other than their school's library on a weekly basis performed better than those who visited a library occasionally or not at all. However, this effect was no longer significant once the home-level variables were controlled for. Perhaps in Model [3] this variable was acting as a proxy for something like parental education or the extent to which parents value reading.

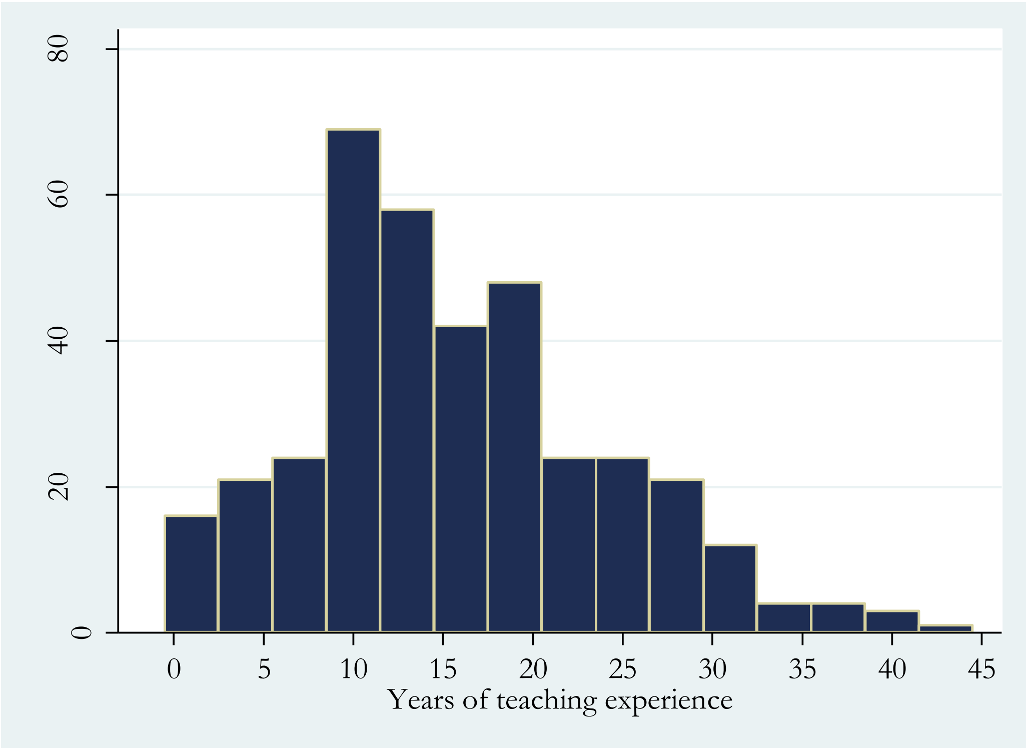
Only three variables from the home questionnaire were found to have significant effects on reading achievement. As Model [4] shows, the effect of at least one parent having a full-time job was to raise the predicted reading score by about 40 points. This effect remained substantial (at around 18 points) and strongly significant in the full model [7]. The coefficient on the dummy for a high level of early literacy activities in the home was positive, consistently around 14 and significant across all the models. The difference, however, between those who were exposed to a "medium" amount of early literacy activity in the home and those who were exposed to little or none, i.e. the reference category, was not significant in Model [4] and weakly significant in Model [7]. This result supports the contention that Early Childhood Development (ECD) has important effects throughout a child's educational development. It also suggests that a large amount of early literacy activity is required in order for it to take effect. For parent education, there was consistently a large, significant and positive coefficient on the dummy for those with at least one parent having education beyond matric. There was, however, no significant difference between those with at least one parent having matric only and those with no parent possessing a matric, the reference category. This may imply that it is only once parents have tertiary education that they begin to really value education and are able to offer effective educational support to their children.

The home-level variables discussed above are each correlated with SES to some extent. For example, affluent parents tend to engage in more educational activity with their children during the pre-school years than do poor parents. The fact that SES was already controlled for in these models may however mean that these home characteristics exercise an effect over and above that of SES. For example, parent education may have direct effects on learning, such as through the value attached to schoolwork in the home or the ability to provide effective support with homework.

It proved particularly difficult to identify teacher characteristics that were consistently associated with statistically significant effects on reading achievement. Students taught by degree-holding teachers performed about 25 points better than those taught by teachers with lower levels of qualification. A similar effect was found when teachers reported the number of hours used for actual teaching as more than 50% of the total available school hours. However, both of these effects were no longer significant once the school-level variables were controlled for. This probably relates to the phenomenon that aspects of teacher quality tend to be highly correlated with overall school quality. Teacher time on task, for example, is a teacher variable but is largely a product of the instructional leadership emanating from senior management in the school.

One teacher characteristic that was associated with reading achievement in the models was the total years of teaching experience. Figure 3.27 shows that the majority of teachers in the sample had between 10 and 20 years of experience, with relatively few inexperienced teachers. Models [5] and [7] contain some evidence of a negative effect associated with older (or at least more experienced) teachers. From the models it would appear that the threshold beyond which the negative effects are significant is around 13 years. Several reasons might underlie the negative association between teacher experience and student achievement, for instance, teacher motivation and teacher understanding of curriculum changes. Certainly, one would expect further research into teacher characteristics and student outcomes by teaching experience to yield interesting insights.

Figure 3.27: Histogram of teacher experience

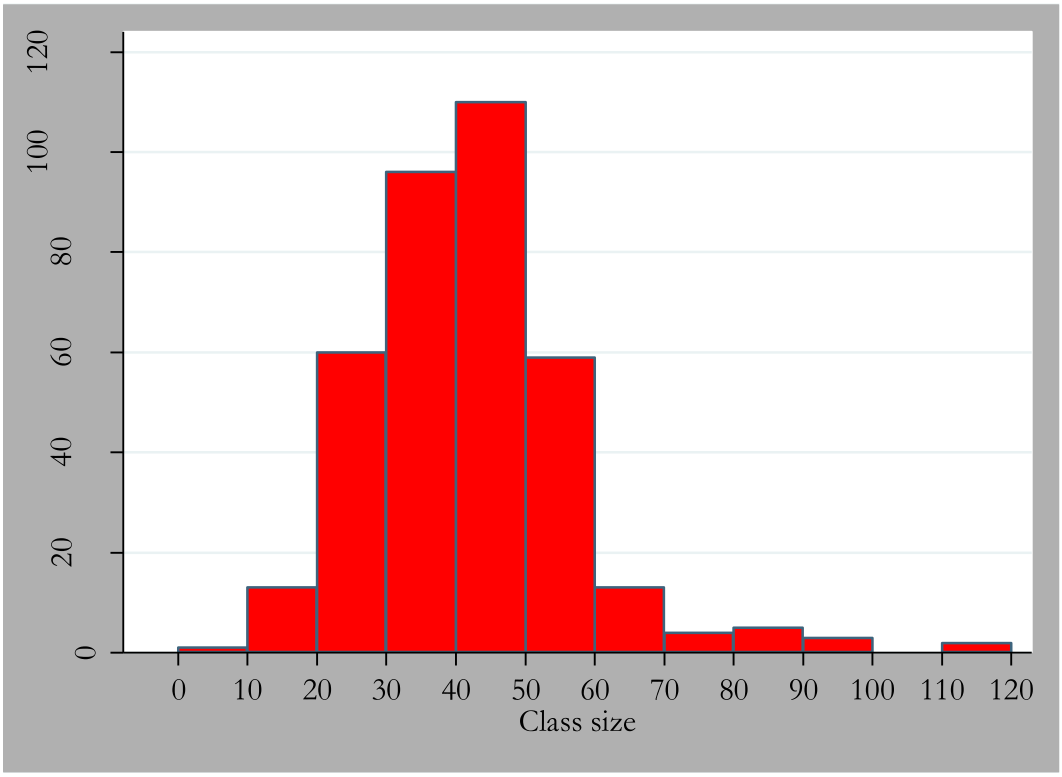


Class size is one teacher-level variable that did come through significantly in Model [5] and the full model. Class size as used here refers to the number of children in a class under the supervision of one teacher at any point in time. This is distinct from the pupil-teacher ratio, which, although sometimes used as a proxy for class size, refers to the ratio of teachers in a school to the total number of students enrolled. As Table 3.8 shows, a quadratic specification of class size was justified by the statistical significance of class size squared. The positive coefficient on the square of class size indicates that the negative relationship between class size and reading achievement flattens out at higher levels of class size.

It is worth diverging here into some more detailed consideration of class size effects before continuing to discuss the results in Table 3.8. The issue of class size has received considerable research and policy attention based on a mixed array of evidence. In both industrialised and developing countries, mixed results have been obtained via numerous research methodologies ranging from extensive meta-analyses (in the tradition of Glass and Smith, 1978) to production functions and randomised experiments. Probably the most influential South African study on class size (strictly speaking, pupil-teacher ratio in this case) was published by Case and Deaton (1999). This study noted that in schools attended by black students in 1993, pupil-teacher ratios varied widely across magisterial districts. In consequence of the restrictions on movement imposed during the apartheid dispensation, Case and Deaton felt it was justifiable to merge pupil-teacher ratios to household survey data on the basis of magisterial district. They found that pupil-teacher ratios were significantly associated with enrolment, years of schooling attained and test scores. Despite the prominence of this study in the South African literature, however, various doubts have been raised (for example, by Crouch and Mabogoane, 1998) regarding the assumptions of the study and its data.

Not only has evidence been mixed on whether class size makes a difference, but when this is translated into a budgetary framework it usually turns out to be one of the least cost-efficient policy alternatives, as Gustafsson and Mabogoane (2010: 12) argue. There are nevertheless at least two good reasons to examine the effect of class size further using the PIRLS data for South Africa. Firstly, as Zuze (2008: 50) observes, studies conducted at the primary school level have produced more conclusive evidence that class size matters than have secondary school studies. Secondly, class sizes in South African schools are abnormally large by international standards. According to Lockheed and Verspoor (1991), estimates of average class size in developing countries between 1965 and 1985 were constantly in the range of 39 to 42, while in industrialised countries this figure decreased from 28 to 20 over this period. In contrast, Gustafsson and Patel (2009: 26) estimate that about 16% of grade 8 students in South Africa are in classes larger than 55. In the PIRLS sample, a quarter of South African students are in classes larger than 52. Thus, despite international evidence on class size being mixed, excessively large classes may mean that there are salient thresholds beyond which class size does have a significantly detrimental effect on learning. A histogram describing the range of class sizes in PIRLS is presented in Figure 3.28.

Figure 3.28: Histogram of class sizes in South Africa



For the purposes of closer analysis class size was divided into 5 splines with the following cut-off points: 0 to 30, 30 to 40, 40 to 50, 50 to 60 and 60 plus. Table 3.10 presents three regression models in which class size is entered in the form of splines. This means that the marginal effect of changes in class size will be estimated separately for each spline. Model [A] reports the results of an unconditional regression predicting reading achievement by class size splines. The way to interpret the coefficients is as follows. A one unit increase in class size in the range of 30 to 40 is associated with a decrease in the predicted reading score of 2.29 points. However, a one unit increase in class size in the range of 40 to 50 is associated with a decrease in the predicted reading score of 5.38 points. It is helpful to graph the predicted reading score by class size to ease the interpretation of the coefficients. Figure 3.29 shows the predicted reading score based on Model [A].

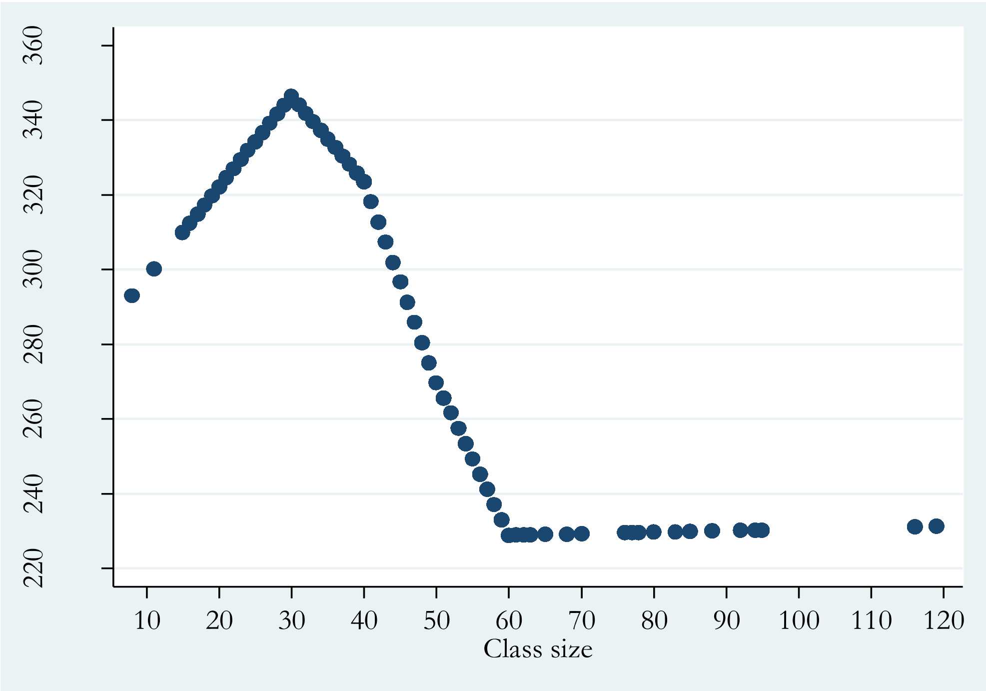
Table 3.10: OLS regression models with class size splines

	[A] – full sample	**[B] – full sample**	**[C] – African language schools**
Class size 0 to 30	2.43***	1.92***	1.53***
	(0.50)	(0.36)	(0.39)
Class size 30 to 40	-2.29***	-1.27***	-1.20***
	(0.43)	(0.31)	(0.34)
Class size 40 to 50	-5.38***	-0.72*	0.49
	(0.45)	(0.33)	(0.35)
Class size 50 to 60	-4.08***	-3.70***	-2.89***
	(0.56)	(0.40)	(0.39)
Class size 60 plus	0.04	0.35	0.01
	(0.26)	(0.18)	(0.16)
SES		11.50***	7.24***
		(0.98)	(1.04)
School mean SES		-62.23***	2.56
		(2.76)	(4.59)
School mean SES squared		20.84***	3.88***
		(0.44)	(0.96)
Constant	273.55***	213.86***	174.50***
	(13.17)	(9.84)	(10.71)
R-squared	0.081	0.534	0.086
N	13342	13342	9185

Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

Figure 3.29: Predicted reading score by class size (based on Model [A])



The figure demonstrates that there is actually a positive association between class size and reading scores when class size is very low. The predicted reading score is highest when there are 30 students in a class. Within the range of 30 to 60 increases in class size are associated with lower scores. This effect is greatest within the range of 40 to 50 but is also large between 50 and 60. Amongst classes larger than 60 the predicted level of achievement is very low and remains fairly constant as class size increases even further.

Model [B] includes student SES and the mean SES in each school in order to test whether the class size patterns remain the same once these factors that have been shown to explain much of the variation in reading scores are controlled for. The overall pattern is mostly in line with that emerging from the unconditional model. Significant negative effects of class size increases are predicted within the range of 30 to 60. However, the most dramatic effects are linked to changes of class size within the range of 50 to 60 – lowering class size from 60 to 50 is associated with an improvement in the predicted reading score of 37 points. Table 3.11 provides perspective by showing the expected benefits associated with lowering class size by 10 at different levels.

Table 3.11: Expected benefits associated with lowering class size

Change in class size	**Associated benefit predicted by Model [B]**
lowering class size from 60 to 50	37.0 point improvement
lowering class size from 50 to 40	7.2 point improvement
lowering class size from 40 to 30	12.7 point improvement
lowering class size beneath 30	no benefit

It should be noted that the expected benefits reported in Table 3.11 would in actuality probably be somewhat smaller if a fuller set of teacher and school characteristics was controlled for. Nevertheless, this analysis does suggest that a fairly large benefit may be expected if particularly large classes could be lowered to 50 students at most. Model [C] confirms that the same pattern applies to the African language schools – predicted reading achievement is most responsive to changes in class size within the range of 50 to 60. The effect is slightly smaller, however, probably because other unobserved aspects of school quality that differ across the historically different parts of the school system are to some extent being proxied for by class size in model [B].

Implementing a reduction in class size across the system by a magnitude such as 10 might be expected to have serious budgetary implications. However, reducing class size to 50 is probably not a matter of simply employing more teachers. The phenomenon of very large classes in South Africa is usually a matter of school management, with the exception perhaps of certain rural areas where teacher shortages are experienced. Large classes combined with too many "free" periods for teachers often occurs when schools principals do not understand how to deploy teachers effectively within the timetable. This relates to a finding to be presented in the next chapter that the lack of an easily available timetable is a good indicator of low school functionality. Gustafsson and Patel (2009) investigated class sizes in South Africa using data from the Annual Survey of Schools. According to this data the mean class size was 47.2 students. Gustafsson and Patel (2009: 27) estimate that if schools ensured that classes were of equal size and the available time for teaching was put to maximum use, the mean class size could be reduced from 47.2 to 37.8. If such a large reduction might be possible at the mean then surely there is scope to reduce exceptionally large classes to a maximum of 50 simply through a better utilisation of time at school. Although there is currently no official policy governing class size in South Africa, it may be worth implementing some mechanism to put pressure on schools to reduce class size, perhaps through raising parent awareness and expectations of what class sizes should be.

Consider again the results of the models in Table 3.8. In model [6], where the school characteristics were introduced, very large and significant positive coefficients were obtained for the dummies capturing whether a school took the test in Afrikaans or English.[33] The size of these effects diminished somewhat in the full model where school mean SES was included. This decrease probably indicates that the "Afrikaans" and "English" dummies were to some extent capturing the effect of school SES in model [6]. However, the fact that large coefficients were still obtained in the full model indicates that there is a school system effect at work that operates over and above the effect of SES. The full model conditions upon student SES and its square, parent education variables, a dummy for whether either parent has a full-time job and school mean SES and its square. These are all indicators of SES and yet there remains a sizable

[33] The reference category is therefore schools that took the test in an African language.

premium associated with being in a school that took the test in Afrikaans or English. It is likely that unobserved differences in management and teacher practice between the historically different school systems account for this result.

Students in rural schools performed somewhat worse than those in urban and semi-urban areas. This effect was smaller in magnitude when controlling for school SES. According to model [6], students in schools in which the principal reported that student absenteeism was severe performed worse than those in schools where absenteeism was purportedly moderate, who in turn performed worse than those where absenteeism was apparently not a problem. However, these effects were less prominent once school SES was controlled for in Model [7]. Only the coefficient for severe absenteeism was significant at the 90% level of confidence. This may reflect the phenomenon that numerous aspects of school quality, such as the level of absenteeism, are correlated with school SES. Put differently, high absenteeism may be an example of the sort of problem that exists in less well-functioning schools, which tend also to be poor schools.

A noteworthy result is that the variables describing school resources did not consistently predict reading achievement. The "LTSM shortage" index summarises a number of questions in the school principal questionnaire regarding the extent of shortages of items that could (in the opinion of the author) be grouped together as LTSM. Examples of these items are audio-visual apparatus, computers and instructional materials. Similarly, the "infrastructure shortage" index was derived from a number of variables describing the extent of shortages of resources that could be grouped together as school infrastructure. These included lighting systems, instructional space and school buildings. In Model [6], which did not control for student, home and teacher characteristics or school mean SES, only the dummy for a severe shortage of infrastructure was statistically significant. When the other characteristics were controlled for both the "LTSM shortage" index and the "infrastructure shortage" index were insignificant and were thus not included in the full model.

This result adds to the growing realisation that resources do not guarantee educational achievement. It has been observed by Fiske and Ladd (2004), for example, that the considerable improvement in fiscal equity in South African education since transition has not been accompanied by a corresponding improvement in equality of educational outcomes. As Van der

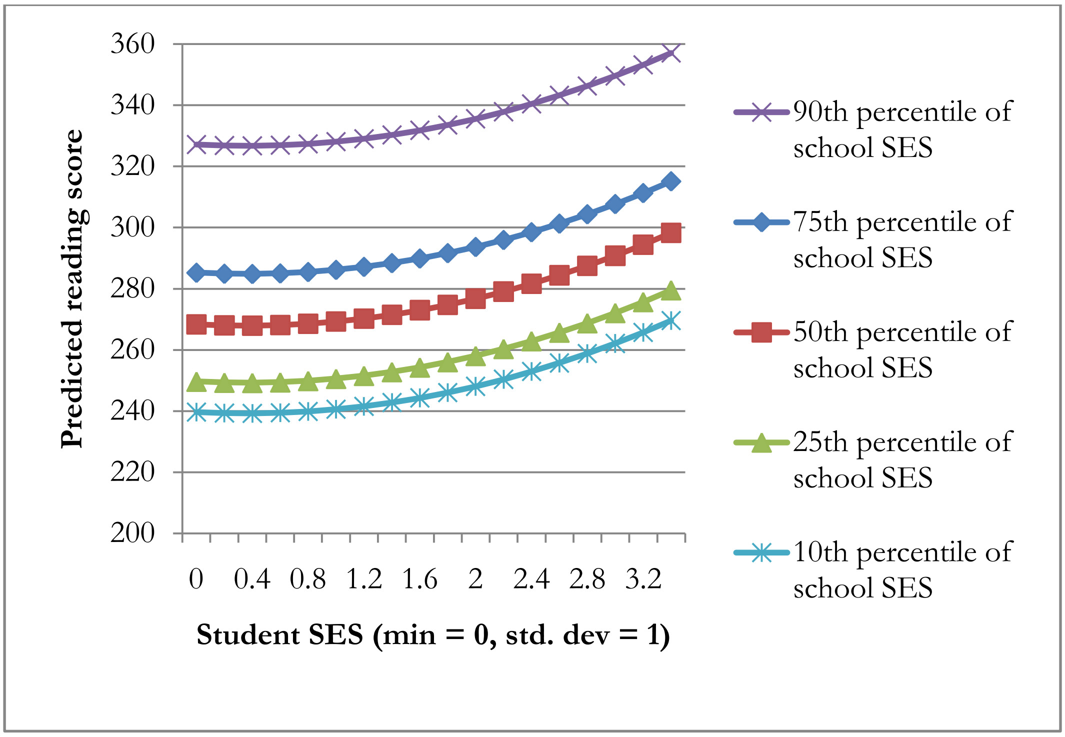
Berg (2008: 145) describes it, resources matter conditionally upon school efficiency, which can be thought of as the ability of schools to convert resources into outcomes. This ability appears to vary widely between South African schools. Some time ago Crouch and Mabogoane (1998) estimated that school efficiency, conceived of in this way, accounted for approximately 25% of the overall variation in educational performance in South Africa.

Once the full set of explanatory variables was included in model [7] the estimated effect of student SES was considerably smaller than in the basic socio-economic gradient models. It nevertheless remained statistically significant and consequential in magnitude. Figure 3.30 describes the relationship between student SES and reading achievement at different levels of school mean SES. The figure is derived from model [7] with student SES and school mean SES varying, but all the other variables held constant.[34] The three lines can be loosely thought of as conditional socio-economic gradients at the 10th, 25th, 50th, 75th and 90th percentiles of school mean SES.

Several points relating to Figure 3.30 are important. Firstly, the gradients are considerably flatter than the unconditional socio-economic gradient presented in Section 3.4. This is due to the inclusion of the full range of explanatory variables, most notably school mean SES. The figure demonstrates that changes in school mean SES (movements *of* the curves) are associated with larger gains in predicted reading achievement than are changes in student SES (movements *along* the curves). This confirms the view of the Coleman Report (1966) that the combined SES within a classroom should be considered a key educational resource. Another dramatic feature of the figure is the large disparity between the predicted achievement at the 75th percentile and the 90th percentile of school mean SES. This no doubt reflects the superior performance of the historically privileged and well-functioning part of the system. Again, the incentive to migrate to the better functioning part of the school system is apparent and the interpretation of the effect of SES on schooling outcomes in South Africa suggested in Section 3.4.5 is pertinent: individual home SES may be a major determinant of the quality of schooling students to which students gain access. Thereafter, home SES is limited in its ability to influence educational achievement.

[34] The gradients were estimated assuming that individuals spoke the language of the test at home at least sometimes, felt safe at school and were in classes of 45 students. All other characteristics were assumed to be such that all the dummy variables in model [7] took a value of zero. Due to these assumptions the exact level of the lines is not directly relevant. The point of the figure is rather to describe the relative effects of student SES and school SES.

Figure 3.30: Conditional socio-economic gradients at different levels of school mean SES



3.6.2.2) Separate OLS models for the historically different parts of the school system

In Section 3.4.5, when investigating the socio-economic gradient for South Africa, it was clear that separate analysis of the two historically different sections of the school system revealed different processes beneath the overall picture. For the same reasons it is worth estimating separate multivariate production function models for each these two groups of schools. This follows the recommendations of both Van der Berg (2008), who highlights the different data generating processes in each of the sub-systems, and Gustafsson (2007: 94), who argues that important dynamics that are present in one section of the system may be glossed over by a single model for South Africa. Gustafsson therefore maintains that separate education production functions for historically advantaged and disadvantaged schools are more useful for the purposes of informing policy.

Table 3.12 presents separate models based on the classification used in earlier sections, which was based on the language in which schools chose to take the test.[35] Column [1] reports the

[35] As before, those schools that took the test in English but where less than 30% of the students reportedly always spoke English at home were excluded from the Afrikaans and English language group. Neither were they included in the African language group.

model for the full sample as was presented in Table 3.8 (Model [7]). Column [2] reports the estimates obtained for those schools that took the test in an African language. This is a relevant part of the table for policy as it illuminates teacher or school characteristics that are associated with better reading achievement in the historically disadvantaged and less well-performing part of the system. The chief value of Column [3] is for comparison.

One interesting difference between the model for the entire sample and the restricted models in Columns [2] and [3] is that the squares of SES and of school SES were not statistically significant in the restricted models and were therefore omitted. This shows that the non-linearity in the relationship between SES and reading achievement that was evident in the model for all South African schools was due to differences between the two school "systems", rather than due to something inherent in the way SES affects learning, confirming what was concluded from Figure 3.20 in Section 3.4.5, where lowess-type gradients were presented for the two school "systems" and for the overall South African sample. It was noted that the flat section of the overall lowess curve seemed to be driven mainly by the African language schools, and the steep section was entirely accounted for by the Afrikaans and English language schools. The non-linearity observed in the relationship between SES and reading achievement in South Africa therefore appears to be driven by two separate data generating processes corresponding to the two historically different school systems.

Table 3.12: Separate OLS models for the historically different parts of the school system

	[1] Full SA sample		[2] African language		[3] Afr/English language	
Student-level variables						
SES	-2.35	(3.95)	6.25***	(1.26)	9.93***	(2.70)
SES squared	3.28**	(1.16)				
Under 11	-26.81***	(2.55)	-18.98***	(2.17)	-40.23***	(4.67)
Over 11	-33.83***	(4.55)	-26.16***	(4.27)	-42.24***	(11.44)
Female	27.13***	(1.82)	30.51***	(2.02)	20.05***	(3.65)
Speak language of test	33.38***	(3.87)	25.29***	(3.99)	52.46***	(10.91)
Homework more	15.49***	(2.88)	13.50***	(2.74)		
Homework less	12.96**	(4.27)	3.62	(4.26)		
Help unnecessary	16.66***	(3.29)	2.93	(3.61)	25.84***	(5.12)
Help from parent	9.34***	(2.63)	5.63~	(2.92)	9.29*	(4.50)
More than 10 books					9.35*	(4.52)
Feel safe at school	18.67***	(2.40)	15.99***	(2.44)	8.59~	(4.49)
Home-level variables						
Full-time job	18.64***	(2.36)	14.58***	(2.44)	19.03***	(4.31)
Early literacy: high	13.86***	(3.51)			23.12**	(7.42)
Early literacy: med	6.14~	(3.42)			3.56	(7.79)
Parent matric only	1.74	(4.13)	-0.76	(2.35)	1.72	(5.33)
Parent beyond matric	38.90***	(7.06)	20.62***	(3.77)	36.28***	(6.83)
Teacher-level variables						
Class size	-1.37*	(0.60)	-1.19***	(0.27)	11.72***	(1.47)
Class size squared	0.01*	(0.00)	0.01***	(0.00)	-0.20***	(0.02)
Teacher experience 4 to 7	-18.33	(12.45)	-0.19	(5.34)		
Teacher experience 8 to 12	-13.97	(11.36)	-15.14***	(4.53)	1.76	(7.48)
Teacher experience 13 - 19	-21.66*	(10.20)	-20.07***	(4.42)	-33.28***	(6.49)
Teacher experience 20 plus	-23.75*	(10.32)	-27.30***	(4.40)	-16.79**	(5.66)
Teacher has degree			11.43**	(3.71)	19.89**	(7.08)
School-level variables						
Afrikaans	74.48***	(9.52)				
English	30.13**	(9.50)				
Rural	-18.13*	(8.54)	-12.30***	(2.87)		
Absenteeism: moderate	-10.03	(8.30)	-16.30***	(3.83)	-14.53**	(5.55)
Absenteeism: severe	-15.41~	(7.90)	-21.71***	(3.89)	-38.81***	(6.51)
School SES	-39.17***	(10.20)	7.74***	(1.68)	46.86***	(3.49)
School SES squared	12.37***	(1.89)				
Constant	258.95***	(24.12)	231.23***	(10.71)	-69.03*	(33.23)
Sample size	13342		9185		2412	
R-squared	0.65		0.26		0.68	

Table Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

The model controlled for province and non-response regarding speaking the language of the test at home, frequency of homework, availability of help with homework, feeling safe at school, number of books in the student's home, early home literacy activities, teacher experience, teacher degree, urbanicity of school and absenteeism at schools. Table A.8 in Appendix G reports the complete model statistics with the coefficients on all these additional variables.

In Column [3] the reference category for teacher experience included teachers with 0 to 3 years and those with 4 to 7 years due to the small number of teachers with 0 to 3 years in this group of schools.

There are also several interesting differences in the returns to specific characteristics between the models presented in Table 3.12. Within the Afrikaans and English language schools there were no significant effects related to the reported frequency of homework. One possible reason for this could be that homework practice is fairly uniformly sound in this group of schools, despite a small proportion of students (perhaps inaccurately) reporting infrequent or no homework. In contrast, homework practice may vary substantially within the historically disadvantaged system, affecting student achievement. Homework practice may also be acting as an indicator of general school functionality within this part of the school system.

The performance of students who felt that they did not need help with homework was insignificantly different from those for whom no help was available within the African language model. These students may have been under a false impression that they were progressing at or above the level required of them, possibly due to a lack of assessment feedback to students or a low standard of assessment in these schools. Research by Lam *et al* (2008) and Van der Berg and Shepherd (2008) as well as analysis in Chapter 5 of this thesis demonstrates that assessment in historically black schools often provides a rather inaccurate signal to students.

The advantage associated with receiving help from parents was most prominent in the full South African model. This may indicate that a distinction in the quality of parental support may fall along the same line as the distinction between these two groups of schools. The fact that the coefficient on help from parents in Column [2] is only significant at the 90% level and is comparatively small may reflect a lower quality of parental help that is available to students within African language schools. A similar pattern emerged for the effects of early literacy activities in the home, where no significant effect was obtained in the African language model. Two compatible reasons for this result can be hypothesised: a low quality of early literacy stimulation due to lack of education amongst parents might have rendered such early childhood activities largely ineffective, or a dysfunctional school environment might prevent any advantage of early literacy activities from coming to fruition.

Feeling safe at school seems to matter more within African language schools than Afrikaans and English schools. This is probably due to the reality that violence and disruptive activities are more prevalent in the poorly functioning part of the school system. In both models the benefits to parent education were only significant if at least one parent had education beyond matric. Students whose parents had only matric did not do significantly better than those whose parents had an educational level lower than matric.

The effect of class size in Column [2] is similar to that in the combined model. In the Afrikaans and English schools, however, the effect of class size is concave rather than convex. This is because there are no classes larger than 60 in this group of schools and therefore no flattening out of the effect beyond a class size of 60. In all 3 models, students taught by more experienced teachers did worse. Interestingly, a positive effect for teachers holding a degree was obtained in the models for each of the two groups of schools but not in the combined model. This indicator may distinguish teacher quality within each system but mean different things in the two groups so that when they are combined the effects are concealed. This illustrates the importance of sub-system modelling in South Africa as separate data generating processes are clearly operating.

The same point applies to the estimated effects of problems with absenteeism in each system. Problems with student absenteeism were only weakly associated with achievement in the combined model. However, in Columns [2] and [3] the dummies for both moderate and severe problems with absenteeism were statistically significant and the effects were larger. One reason for this may be that respondents (school principals) gauged the severity of absenteeism in their school relative to other schools in the area or schools that seemed appropriate for comparison. Therefore, a historically privileged school in which absenteeism was deemed severe may in fact have had a less serious problem than a rural African language school in which absenteeism was deemed moderate by the principal. Within each system, however, this variable appears to affect achievement and may also be acting as a proxy for school functionality in general. The magnitude of the effect is considerable. For students within the African language school system, being in a school with severe absenteeism was associated with an expected reading score nearly 22 points below that for students in schools where absenteeism was not deemed to be a problem.

Two other differences between the models for each group of schools are noteworthy. Firstly, the returns to advantageous characteristics are generally smaller within the African language sample. This applies to student, home, teacher and school characteristics. Even the advantage associated with being the right age is greater for students in Afrikaans and English schools. One way to interpret this is that there may be a threshold level of basic school functionality that is required before advantageous characteristics have a noticeable effect. To use an agricultural analogy, seeds sown in a field require the soil to be of a certain quality before the innate quality of those seeds or frequency of receiving water will have any beneficial effects.

Secondly, the proportion of the variation in reading achievement explained by each of the models differs markedly. The R-squared values in Columns [1] and [3] indicate that the models for the entire sample and for the Afrikaans and English samples explain a fairly large amount of the overall variation in reading scores – approximately 65% and 68% respectively. However, the model for the African language sample explains only about 26% of the variation in reading scores within this group. It is likely that the large amount of unexplained variation is due to differences in "hard to observe" characteristics such as organisational efficiency, leadership, the professional ethic amongst teachers and other aspects of school functionality. This gets back to the case made by Crouch and Mabogoane (1998), whose paper entitled, "When the residuals matter more than the coefficients", pointed to the importance of unobserved aspects of school efficiency.

The next section tests the reliability of these production function results by applying HLM to the PIRLS data for South Africa. This technique is considered by some to be technically preferable to OLS when modelling student achievement data.

3.6.3) Multivariate analysis using Hierarchical Linear Modelling (HLM)

3.6.3.1) The HLM methodology

Multilevel modelling or Hierarchical Linear Modelling (HLM) is a technique that has been designed for statistical analysis of data with a nested structure. That is to say that the data consist of individual observations that are nested within groups. The PIRLS dataset fits this category as students are nested within classrooms in schools. When data is nested, group dynamics influence the relationships between individual characteristics and the outcome of interest. For example, the relationship between SES and reading achievement may well differ across schools. In order to deal with this, HLM performs regressions at two levels of analysis: the "within-school" regression model (level 1) and the "between-school" regression model (level 2). At the first level separate regressions explaining reading achievement are estimated within each school. Equations (3.13) and (3.14) describe the "within-school" (level 1) model.

$$y_i = \beta_{0i} + r_i \qquad (3.13)$$

Here y_i denotes the reading scores for the students in the i^{th} school, β_{0i} is the intercept in the i^{th} school, which is the average reading score in the i^{th} school, and r_i represents random error in the i^{th} school. Equation (3.13) is called a fully unconditional model because it does not include any student characteristics as explanatory variables. The random error term (r_i) is therefore the deviation from the average reading score in school i for each student in that school. One can include student characteristics as explanatory variables in the "within-school" model in the following form.

$$y_i = \beta_{0i} + \beta_{1i}X_{1i} + \beta_{2i}X_{2i} + ...\beta_{ni}X_{ni} + r_i \qquad (3.14)$$

Here β_{1i} represents the coefficient on the first explanatory variable (X_1) for the i^{th} school. The X variables are student-level characteristics like SES, gender or age. The β coefficients are thus different for each school. This leads to the level 2 or "between-school" model in which the β

coefficients are explained by school characteristics. The form of the level 2 model is given by equations (3.15) and (3.16).

$$\beta_0 = \theta_{00} + u_0 \tag{3.15}$$

Here θ_{00} is the intercept, which represents the average of all the β_0's across the schools, and u_0 represents the random error across schools. Equation (3.15) is the fully unconditional model because no school level characteristics are included as explanatory variables and u_0 is therefore each school's deviation from the average intercept (β_0). Adding school level characteristics to the level 2 model yields equation (3.16).

$$\beta_0 = \theta_{00} + \theta_{01}S_{01} + \theta_{02}S_{02} + ... + \theta_{0m}S_{0m} + u_0 \tag{3.16}$$

In equation (3.16), θ_{01} is the coefficient on the first school level explanatory variable (S_{01}). The S variables are school-level characteristics such as school mean SES, class size or indicators of teacher quality. The model in equation (3.16) explains differences in average reading achievement between schools. This is called "modelling the intercept" because it models β_0 from the within-school model. Similarly, it is possible to allow the other β coefficients to vary across schools and then model them as part of the level 2 model. For example, if β_1 is the coefficient on student SES it is possible to explore how the relationship between SES and reading achievement differs across schools. This is often referred to as "modelling the slope", in this case the SES slope. The form of this model is described by equation (3.17).

$$\beta_0 = \theta_{10} + \theta_{11}S_{11} + \theta_{12}S_{12} + ... + \theta_{1m}S_{1m} + u_1 \tag{3.17}$$

A common critique of the application of OLS regression to nested data is that if one does not accommodate the fact that students are located within schools, OLS will (incorrectly) treat the data as a simple random sample. The resultant standard errors will therefore be underestimated and the confidence intervals unrealistically tight. It is, however, possible to control for complex sample design using survey regression, as was applied in the OLS analysis in Section 3.6.2. This allows one to specify the Primary Sampling Unit (PSU), which in the case of PIRLS is the classroom, and the stratification method, which in the case of South Africa in PIRLS was done by province. Survey regression thus adjusts the standard errors and confidence intervals accordingly. In fact HLM models do not account for stratification. It is possible to specify a three-level HLM where students are nested within schools, which are in turn nested within provinces, but for the sake of simplicity this was not attempted.

There remain two important benefits to HLM that are worth mentioning here. Since HLM estimates two error terms (*R* and *U*) it is possible to partition the overall variance in reading achievement into "within-school variance" and "between-school variance". This was explained in Section 3.5.1 when the *rho* values were calculated from the variance of the error terms in the fully unconditional level 1 and level 2 HLM models. A second benefit is that HLM portrays the interaction of variables across the levels. For example, it is possible to observe how school mean SES influences the way individual SES impacts on reading achievement. Raudenbush and Bryk (2002: 5) touch on both these advantages by arguing that HLMs can be used to "pose hypotheses about relationships occurring at each level and across levels and also assess the amount of variation at each level."

One word of caution is warranted in the midst of the potential benefits that are vigorously listed by proponents of HLM: the intuition of the multi-level approach can be rather confusing to the uninitiated and the subsequent model coefficients and statistics even less accessible. Johnes (2004: 647) describes this methodology as "computationally intractable". This is a significant drawback when effective dissemination of educational research is intended.

3.6.3.2) An HLM model for the entire South African sample in PIRLS

The HLM analysis was conducted in a similar manner to the OLS analysis in that a model was specified for the entire South African sample and then separate models were estimated for the two historically different parts of the system. As a general rule, variables that were not found to be statistically significant were omitted from the models, as was the procedure in the OLS regression. The model for the entire South African sample is presented in Table 3.13.

Table 3.13: Full HLM model for Reading achievement in PIRLS

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	301.75***
School mean SES	37.12***
Class size	-0.59*
Test in Afrikaans	81.77***
Test in English	55.19***
Rural	-33.42**
Teacher experience 4 to 7	-12.75
Teacher experience 8 to 12	-7.41
Teacher experience 13 to 19	-31.61*
Teacher experience 20 plus	-22.91
The student SES achievement slope, β_1	
Intercept	9.18***
School mean SES	3.22*
Class size	-0.12~
Rural	-5.52*
Under age (<11)	-25.08***
Over age (>11)	-20.67***
Female	28.81***
Speak the language of test at home	31.59***
Homework less than once a week	7.23~
Homework more than once a week	13.77***
Help at home unnecessary	9.45**
Help from parent	3.81
Feel safe at school	11.27***
Early literacy activities: high, β_{14}	
Intercept	10.32**
School mean SES	4.73**
Time spent teaching > 50%	9.26*
Early literacy activities: medium	0.01
A Parent has matric only	-2.88
Parent education beyond matric	24.26***
Parent has fulltime job	13.05***

Random effects	**Variance Components**
Intercept, $\mu 0j$	2671.35***
Student SES slope, $\mu 1j$	18.24**
Early literacy activities slope, $\mu 14j$	25.01~
Level-1 error, rij (σ^2)	4246.30

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Only the student SES achievement slope and the high early literacy activities achievement gap were allowed to vary between schools and were group-mean centred.

The model controlled for non-response regarding whether the language of the test was spoken at home, frequency of homework, availability of help with homework, early home literacy activities, the number of library books at schools and the urbanicity of schools. Table A.9 in Appendix G reports the complete model statistics with the coefficients on all these additional variables.

Rho value (ICC) = 0.67
Proportion of within-school variance explained by the model = 0.18
Proportion of between-school variance in β_0 explained by the model = 0.74
Proportion of between-school variance in β_1 explained by the model = 0.58
Proportion of between-school variance in β_{14} explained by the model = 0.67

The first step in the model construction was to run the fully unconditional model, which yielded a *rho* value of 0.67. This means that 67% of the overall variance in South Africa's reading scores is attributable to "between-school variance" and 33% is attributable to "within-school" variance. As discussed in Section 3.5.1, this *rho* value is particularly high by international standards.

The second step in the model construction was to identify student-level variables for inclusion in the within-school (level-1) model. A large number of variables were tried and, happily, the same combination of student-level variables that were included in the OLS full model (Column [1] of Table 3.12) produced the most appropriate HLM.[36] Moreover, the coefficients on all of these variables had the same sign as had been the case in the OLS model. The value of the average intercept (301.75) represents the predicted reading score for a student with average characteristics in the average school.[37]

The magnitudes of the estimated effects were not drastically different from those estimated using OLS. However, in general the estimated effects on the student-level variables were somewhat smaller in the HLM than in the OLS model. This is in line with what Gustafsson (2007) found when comparing OLS and HLM estimates for South Africa using the SACMEQ II data. A

[36] One exception is that the square of SES was not included in the HLM in order to allow for postestimation graphing options involving SES using the HLM software. The same applies to the level-2 model where school mean SES was omitted for the same reason.
[37] The HLM software grand-mean centres the explanatory variables so that the average value of dummy variables is equal to the proportion of observations that take a value of 1 for that dummy. It is therefore possible in HLM to speak of a student with average characteristics.

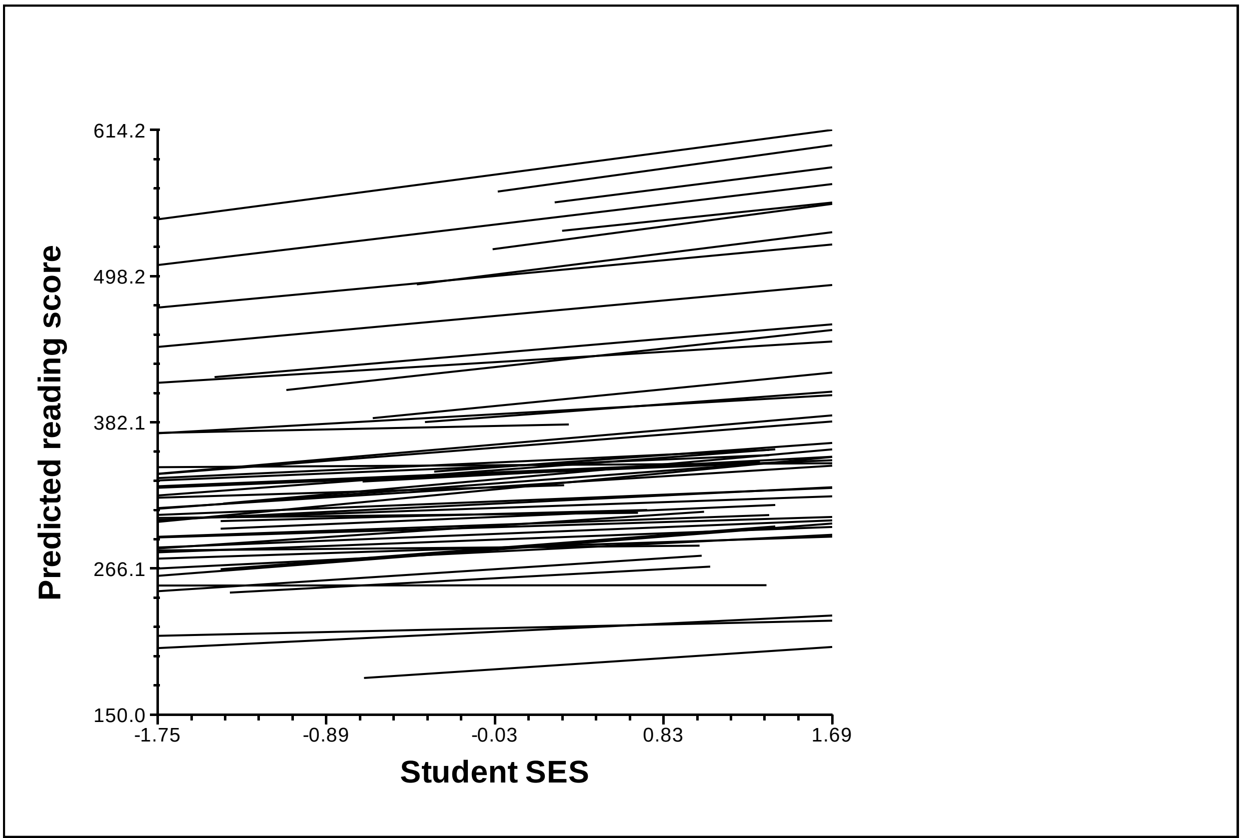
noteworthy result from the level 1 model that is consistent with the OLS modelling is that parent education is only significantly associated with achievement once it exceeds matric.

The third step was to construct the between-school (level 2) model. As one would expect, the within-school intercept (average reading score within each school) varied significantly across schools. The model for the intercept yielded little that was unexpected given the results of the OLS models. As was the case in the OLS models, school mean SES had a large and highly significant effect on the average reading achievement of schools. The dummies for taking the test in English and Afrikaans had very large coefficients, roughly reflecting the two historically different systems. The coefficient on class size was negative, small and significant at the 95% level. Decreasing class size by ten students was associated with an increase in the predicted reading score of 5.9 points – a magnitude similar to that obtained in the OLS regression. The estimated effect of being in a rural school was somewhat greater than was the case in the OLS model. This may be due to the fact that the square of school mean SES was not included in the HLM model but was in the OLS model. The rural dummy may thus to some extent reflect a school SES effect.

The model for the intercept also showed that weaker achievement was associated with more teaching experience. As mentioned in the previous section, a reliable interpretation and policy implications of this result are not self-evident. At most, this result should serve as a flag for potentially important follow up research. Apart from teacher experience, it was not possible to identify many teacher characteristics that justified inclusion in the model. This does not necessarily mean that teacher quality does not matter. Rather, it may simply reflect that surveys such as PIRLS do not always successfully capture robust indicators of teacher quality. Alternatively, the low predictive power of teacher variables may reflect the phenomenon that aspects of teacher quality are highly correlated with school quality in general and with school SES, which were included in the model.

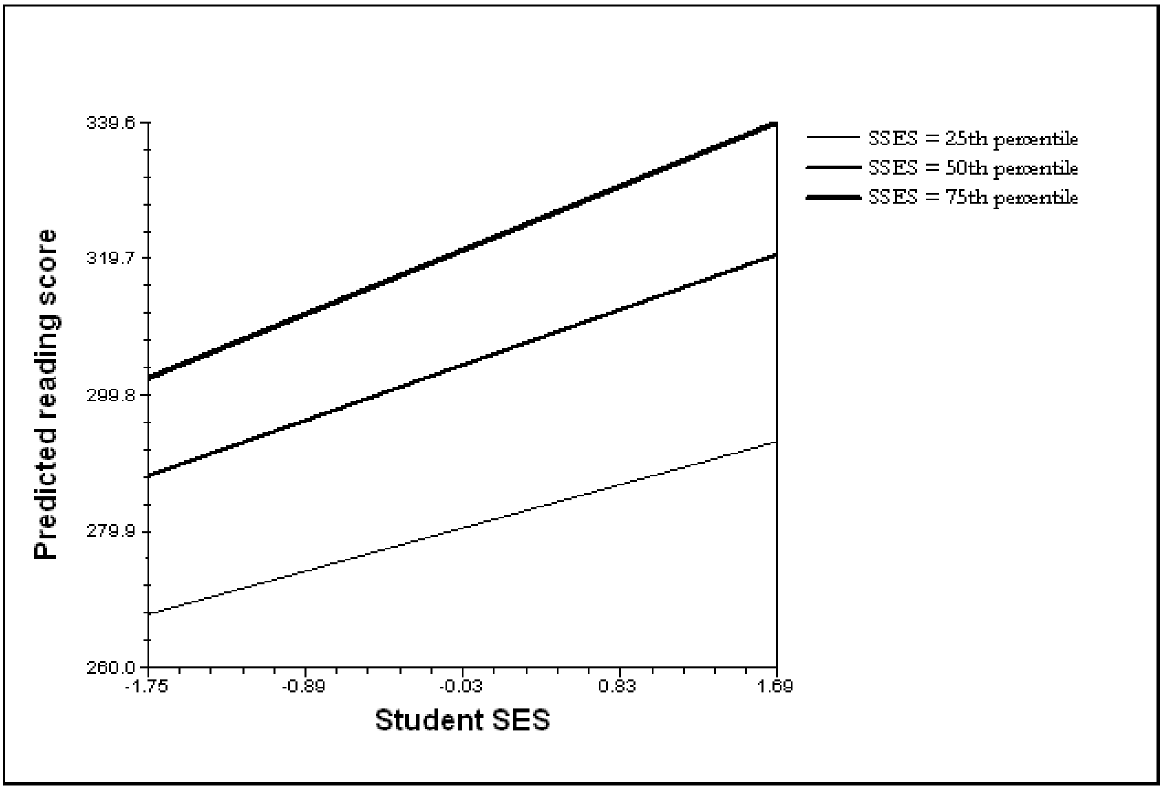
Moreover, the SES slope was found to vary significantly between schools, indicating that the relationship between SES and reading achievement differed across schools. In Figure 3.31 the SES slopes for a random sample of schools are shown to provide an idea of how the slopes vary across schools.

Figure 3.31: Random sample of SES slopes within schools



The model for the student SES achievement slope provides some interesting insights that take the socio-economic gradient analysis somewhat further. On average, a one standard deviation increase in student SES was associated with a gain in reading achievement of 9.18 points. However, the positive and significant coefficient on school mean SES of 3.22 indicates that the gradient was steeper in schools with more affluent student bodies. This result is probably capturing the same trend that was noted in Section 3.4.5, namely that the overall socio-economic gradient for South Africa can be decomposed into a flat gradient for the historically disadvantaged system (at low SES) and a steep gradient for the historically privileged and high SES schools. Figure 3.32 depicts the relationship between student SES and reading achievement at different levels of school SES.

Figure 3.32: Student SES slopes at varying school mean SES

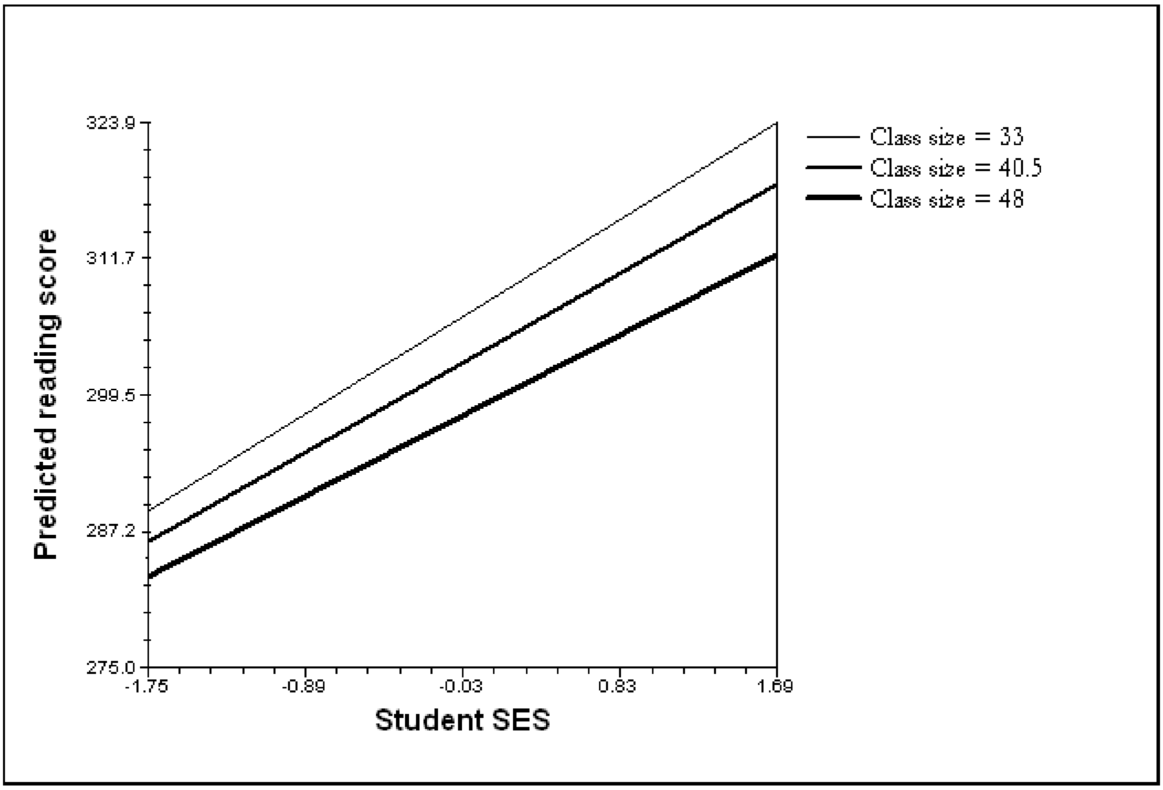


The most dramatic aspect of Figure 3.32 is the large gap between the three slopes. This indicates that the effect of school SES dominates the potential effect of personal SES within a given school. In addition to the considerable gaps between the slopes, the figure also highlights the important trend that the steepness of the slopes is greater at higher levels of school SES.

The SES slope is also flatter in schools with bigger classes and in schools that are located in rural areas.[38] Figure 3.33 shows the relationship between student SES and reading achievement at the 25th, 50th and 75th percentiles of class sizes, controlling for all else in the model.[39] The gaps between the slopes indicate the size of the effect of class size on reading achievement, which is -0.59 per one student increase on average. The gradients are also somewhat steeper within smaller classes, implying that more affluent students are better able to take advantage of the benefit of a smaller class than less affluent students, although the difference is fairly small.

[38] This finding is different to that by Sirin (2005), whose meta-analysis of studies looking at the association between SES and academic achievement found that (at least in the USA) the association was weaker in urban areas than in non-urban areas. Locally specific factors probably account for these different findings. In South Africa rural schools are generally less affluent than urban schools and it has been shown that the SES slope is greater at higher levels of SES. The socio-economic difference might therefore be driving this result.
[39] Figures 3.32 and 3.33 demonstrate the convenience of HLM for analysing the interactions between student and school characteristics, while still modelling these variables at their respective levels.

Figure 3.33: Student SES slopes for varying class size



The gap between those who had been exposed to a high level of early literacy activities in the home and those who had been exposed to none or very little was also found to vary significantly across schools. Although this was not anticipated, the early literacy gap was therefore group-mean centred, was allowed to vary between schools and was modelled at the second level along with the SES slope and the intercept.

The results of the level 2 model for the gap between high levels of early literacy activities versus little or no early literacy activities, are interesting but should not on their own form the basis for any strong conclusions. On average, students who had a high level of early literacy activity had a performance advantage of 10.32 points. However, this advantage was greater in higher SES schools and in schools where the teacher reported spending at least 50% of total school hours on actual teaching. This would suggest that there is a greater return to early literacy activity in higher SES schools and in schools where teaching time is prioritised. Thinking of school SES and time spent teaching as indicators of school functionality, it makes sense that students who arrive at school with a better grounding stand to gain more from being in a functional education environment than do students who were not exposed to sufficient pre-school reading activity.

This, as well as the finding that smaller classes benefit affluent students more than poor students, fits well with the "good soil" hypothesis proposed earlier.

In OLS regression the R-squared statistic estimates the proportion of the overall variance that is explained by the model. In HLM, however, the overall variance is partitioned into "within-school" variance and "between-school" variance. Therefore, the proportions of variance explained at each level by the model can be estimated as an indication of the explanatory power of the model. In this case approximately 18% of the level 1 (within-school) variance is explained by the model. A far greater proportion of the level 2 variance is explained by the model. Approximately 74% of the variance in the intercept (average reading achievement of schools) is explained by the level 2 variables. Similarly, the model explains 58% and 67% of the variance in the SES slope and early literacy activity gap respectively. It is typically the case that HLM models for school data are able to explain more level 2 variance than level 1 variance, as Gustafsson (2007: 91) observes. He puts this down to two factors – firstly that surveys such as PIRLS, TIMSS and SACMEQ are designed primarily to identify teacher and school characteristics that are associated with educational achievement, and secondly that peer effects play an important role in the schooling process. On the other hand, much of the level 1 variance is driven by unobservable characteristics such as innate ability and motivation.

The fact that 74% of the variance in the intercept is explained is encouraging from the perspective of the model design. It is also indicative that so much of what lies behind the differential performance of South Africa's schools comes down to the socioeconomic environment of schools. This assertion is based on the importance of the school mean SES variable in the model as well as the fact that the Afrikaans and English dummies are themselves acting as proxies for SES to some extent.

In Section 3.6.2.2, separate OLS models for the two historically different parts of the school system were compared. It was observed that in general there were smaller returns to characteristics in the model for African language schools than in the model for schools that took the test in Afrikaans or English. Also, much less of the variation in reading achievement within each school "system" could be explained by the former model than by the latter. The pattern that seems to be emerging is that there are different returns to individual characteristics across the two school systems, one of which demonstrates a fair level of general functionality while the other seems to be operating at a disturbingly low level of functionality. To further investigate this pattern, HLM models were estimated for each of the two "sub-systems".

3.6.3.2) An HLM model for the African language schools

Table 3.14 reports the results of the model for African language schools only.[40] The intercept or mean of each school's average reading achievement is considerably lower in the African language model than it was in the full model, reflecting the low overall level of performance of this part of the school system. For the most part, the directions and magnitudes of the estimated effects of student-level characteristics were similar to those in the full HLM model, although sometimes these effects were slightly smaller in the model for African language schools, for example, the coefficient on the dummy for a parent having education beyond matric. Once again, returns to parental education only became significant at high levels of parent education.

Two variables that were included in the level 1 model for the full sample were found not to be statistically significant in the model for African language schools and were therefore excluded from the analysis. These were the dummies for the availability of parental help with homework and the dummies for early literacy activities. This result is probably attributable to a combination of two dynamics. On the one hand, the quality of parental support available during the early years – and later with homework – may be inadequate to significantly benefit child learning. On the other hand, the historically disadvantaged system may be operating below a threshold level of basic functionality that is necessary for normally advantageous student-level characteristics to yield a substantial return.

[40] The sample for the African language model consists of 9837 students in 265 schools.

Table 3.14: HLM model for African language schools only

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	253.41***
School mean SES	15.99***
Rural	-20.72**
Teacher experience 4 to 7	-3.46
Teacher experience 8 to 12	-27.87*
Teacher experience 13 to 19	-31.00*
Teacher experience 20 plus	-33.89**
The student SES achievement slope, β_1	
Intercept	6.11***
School mean SES	2.27
Class size	-0.13*
Under age (<11)	-22.01***
Over age (>11)	-19.98***
Female	31.86***
Speak the language of test at home	27.69***
Homework less than once a week	1.43
Homework more than once a week	11.91***
Feel safe at school	10.26***
A Parent has matric only	-4.26
Parent education beyond matric	19.82***
Parent has fulltime job	11.13***

Random effects	**Variance Components**
Intercept, µ0j	1703.87***
Student SES slope, µ1j	7.60~
Level-1 error, rij (σ^2)	4002.94

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Note: Only the student SES achievement slope was allowed to vary between schools and was group-mean centered.

The model controlled for non-response regarding whether the language of the test was spoken at home, frequency of homework and urbanicity of school. Table A.10 in Appendix G reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.34
Proportion of within-school variance explained by the model = 0.16
Proportion of between-school variance in β_0 explained by the model = 0.30
Proportion of between-school variance in β_1 explained by the model = 0.19

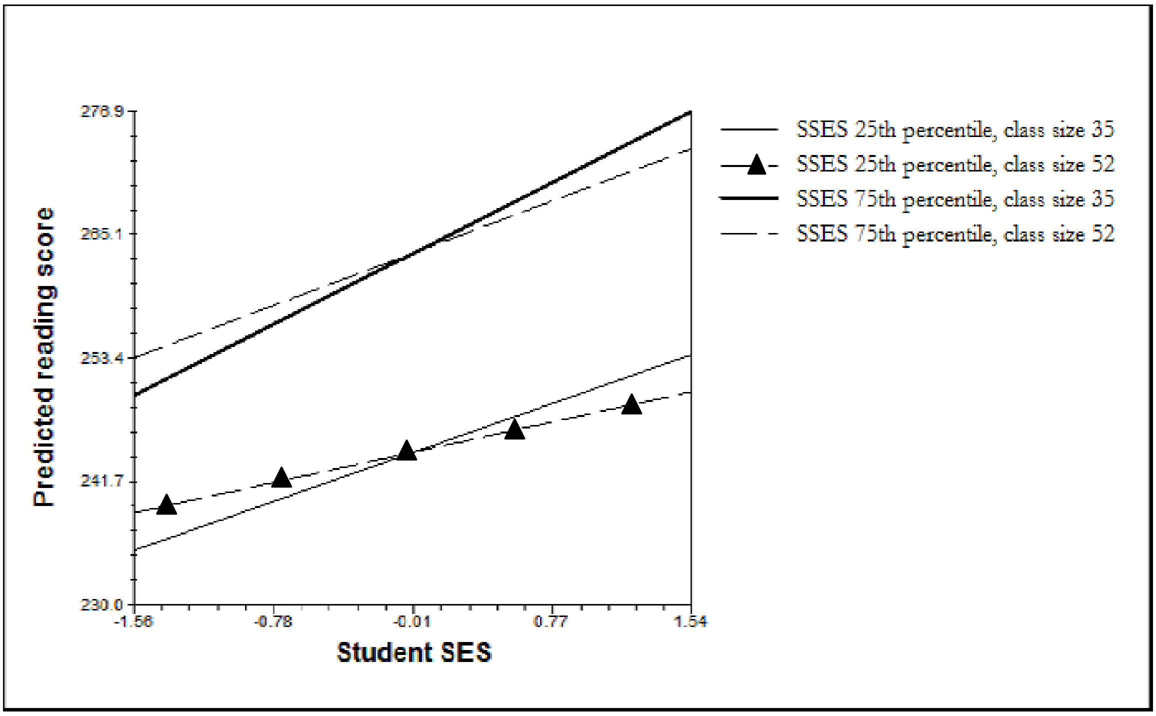
The search for school and teacher characteristics that are associated with reading achievement in this category of schools was rather unproductive, as was the case when modelling this group of schools using OLS regression. Only school mean SES, the dummy for being located in a rural area and teacher experience emerged as significant predictors of the intercept (average reading achievement in schools). The coefficient on school mean SES was smaller than it was in the model for the full sample of schools, reflecting the flatter relationship between SES and reading achievement in the African language sample as has been observed earlier in this chapter. Only 30% of the variance in average reading achievement between schools was explained by these three predictors. This is substantially less than was explained by the model for the full sample. The large unexplained variance suggests that there are important unobserved aspects of school quality that drive performance in the historically disadvantaged school system. It is likely that elements of efficiency such as the leadership of school principals, organisational and managerial capacity, the effective use of resources and the work ethic of teachers are key determinants of educational achievement in this system. These dynamics are particularly hard to capture using surveys such as PIRLS and require more extensive investigation into school and teacher practices. Even then, it is often hard to observe these dynamics and to avoid the problem of changed behaviour in response to the research.

There was enough variation in the student SES slope between schools to warrant the group-mean centering of this beta coefficient, allowing it to vary across schools and searching for predictors.[41] Only class size emerged as a statistically significant predictor of the SES slope, although the t-statistic for school mean SES was greater than one and was therefore still included in the model. It is interesting that class size was not significant in the model for the intercept but was significant in the model for the SES slope. This may be merely an artefact of the data and does not necessarily constitute an important finding. Nonetheless, the relationship between student SES and reading achievement at different levels of school mean SES and different class sizes according to the model is shown in Figure 3.34. It is apparent that the predicted reading achievement of those in a class of 35 students is not significantly different from that of those in a class of 52 on average. However, the SES slope is steeper within smaller classes. If smaller classes lend themselves to a more conducive learning environment then this result is consistent with the hypothesis that a favourable school environment is required in order for students with

[41] This means that the relationship between SES and reading achievement differed across schools, and this was statistically significant. This justifies estimating a level 2 model that explains the different slopes across schools, which requires that SES is centered around the mean within each school (group mean centering) as opposed to around the mean of the entire sample (grand mean centering).

advantageous characteristics (such as higher SES) to enjoy significant returns. However, this particular finding is not strong evidence for that hypothesis.

Figure 3.34: Student SES slopes by school mean SES and class size



3.6.3.2) An HLM model for the Afrikaans and English schools

The HLM model for the sample of Afrikaans and English language schools is presented in Table 3.15.[42] This model differs from that for the African language sample in several important respects. The average reading achievement of schools is substantially higher reflecting the superior performance of this part of the school system. The model also shows greater evidence of positive returns to favourable characteristics, and it is able to explain a higher proportion of the variance in reading achievement.

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42 As in the earlier sections, schools that took the test in English but where less than 30% of students always spoke English at home were excluded from this sample. These 49 schools were not included in the African language sample either. The sample for the Afrikaans and English language model thus consists of 2,623 students in 81 schools.

Table 3.15: HLM model for Afrikaans and English schools only

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	420.98***
School mean SES	59.69***
Class size	-2.66***
Library books: 250-5000	7.73
Library books: >5000	34.51*
The student SES achievement slope, β_1	
Intercept	13.44***
Teacher has degree	28.94***
Rural	-12.85**
Under age (<11)	-42.30***
Over age (>11)	-37.57***
Female	21.06***
Speak the language of test at home	37.28***
Help at home unnecessary	24.75**
Help from parent	10.19**
More than ten books at home	7.53*
Early literacy activities: high	22.42***
Early literacy activities: medium	1.57
A Parent has matric only	7.43
Parent education beyond matric	36.63***
Parent has fulltime job	17.33***

Random effects	**Variance Components**
Intercept, $\mu 0j$	1709.54***
Student SES slope, $\mu 1j$	21.90~
Level-1 error, rij (σ^2)	4841.94

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Note: Only the student SES achievement slope was allowed to vary between schools and was group-mean centered.

The model controlled for non-response regarding whether the language of the test was spoken at home, availability of help with homework, early home literacy activities, the number of library books at schools and urbanicity of school. Table A.11 in Appendix G reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.66
Proportion of within-school variance explained by the model = 0.25
Proportion of between-school variance in β_0 explained by the model = 0.87
Proportion of between-school variance in β_1 explained by the model = 0.80

Consider first the level 1 model. The magnitudes of the estimated effects were generally larger than in the models for the full sample and for the African language sample. For example, the advantage of speaking the language of the test at home was 37.28 points as opposed to 27.69. The estimated effects of parental education and the job status of parents were also substantially larger. Moreover, several variables that were not significant predictors of reading achievement within the African language sample were significant in this model. A dummy for having more than ten books at home emerged positively and significantly. There was also a considerable advantage to having parental help for homework available at home. Similarly, the coefficient on the dummy for having been exposed to a high level of early literacy activities was large and significant. These effects were, however, not significant in the model for African language schools. At least two interpretations of these results are plausible, and both may have been at work simultaneously. Firstly, the parents of students in Afrikaans and English schools, being more affluent and better educated, were able to provide more effective home support. Secondly, these students were located in schools that were functional and therefore offered suitably conducive conditions for home background advantages to actually bear fruit. Once again, this is consistent with the "good soil" hypothesis put forward earlier.

On average, an increase in student SES of one standard deviation was associated with an increase in the predicted reading score of just over 13 points. For the African language model this effect was just over 6 points. This difference reflects the non-linearity in the relationship between SES and reading achievement for the overall sample: the gradient is steeper at higher levels of SES. It is also consistent with the pattern of greater returns to characteristics within the historically advantaged and generally well-functioning part of the school system. The model for the SES slope indicated that the slope was flatter in rural schools than in urban or semi urban schools, as was the case in the model for the full sample. Also, the SES slope was significantly steeper in schools where the teacher had completed a degree. Although this result alone does not warrant any strong conclusions (partly due to reservations about sample size), it is interesting that Zuze (2010: 22) also reported a similar result in the case of Botswana. She applied an HLM model to the TIMSS 2002 data for mathematics achievement in Botswana and found that teacher education increased the SES slope. This relationship is intuitively plausible: students with higher SES should be better placed to benefit from more educated teachers, assuming that higher levels of education do in fact improve the quality of teaching.

It is evident that the main driver in the model for the intercept is school mean SES. The estimated effect of a one standard deviation change in school mean SES is a corresponding change in the predicted reading score of 59.69 points. This partly reflects the fact that the Afrikaans and English language sample of schools includes a wider range of school mean SES than the African language sample, especially at the top end. This result is also further evidence of the pivotal role that schools play in the relationship between SES and reading achievement in South Africa: recall that in Section 3.5.2 it was estimated that approximately 79% of the correlation between SES and reading achievement was attributable to the mean SES of schools students attend.

The estimated effect of class size on average reading achievement in schools was significant and considerable, confirming what was found using OLS regression to model achievement within the Afrikaans and English sample, where the estimated effect was of a similar magnitude. Perhaps this part of the school system is operating at a sufficiently high level of general functionality for advantageous school characteristics, such as class size, to exert an observable effect on learning.

A dummy for having a library with more than 5,000 books also came through significantly in the model for the intercept.[43] Interestingly, an alternative specification of the model for the intercept (not presented here) was to include a dummy for schools having a severe shortage of infrastructure. This variable was also a significant predictor of the intercept as long as the library dummies were omitted from the model. Including both sets of dummies in the model yielded insignificant coefficients. It can be concluded from this that there is some evidence that resources make a difference in this part of the school system. There is, however, no evidence from the production functions estimated in this chapter that resources make a difference in the historically disadvantaged school system after controlling for other factors. This is once again supportive of the "good soil" hypothesis and of Van der Berg's (2008: 145) argument that resources matter conditionally, depending on school efficiency.[44]

[43] The dummies for number of library books were not included in the other models as there was only one African language school which had more than 5,000 books. Therefore, this variable would have simply captured a school system effect rather than provide information about library books that would be relevant to policy.

[44] A personal anecdote relating to a school visitation undertaken by the author acting as a fieldworker in May 2008 illustrates how school resources can be ineffective. It was necessary to establish the number of mathematics textbooks present in the school for a particular grade, and initially it seemed that there were none. After a lengthy probe, however, the author witnessed the new discovery by the relevant mathematics teacher and the "admin clerk" that there were in fact textbooks available but that these were still in their boxes in the head of department's office, where they had been for over a year since their delivery!

The HLM analysis has offered certain insights that OLS regression could not. For example, the interactions across different levels of the model and the partitioning of variance between level 1 and level 2 were valuable contributions to the analysis. Encouragingly, the results obtained in the OLS models do not differ substantively from those obtained in the HLM analysis. One implication of this is that survey regression, which adjusts for complex sample design, is not altogether inferior to HLM. The consistency of results is also important because it meets Glewwe's (2002) recommendation that isolated education production function results should not be considered as definitive but that consistent results may indicate a reliable message.

This section has also highlighted the importance of conducting separate multivariate analyses for each of the two historically different (and persistently differently performing) sections within the South African school system. This demonstrated that the historically disadvantaged and predominantly black system is characterised by a low level of performance, small returns to normally advantageous student, teacher and school characteristics, and a large amount of unexplained variation in reading achievement, pointing to issues of internal school efficiency.

The HLM analysis demonstrated that certain school and teacher characteristics affect the extent to which SES influences achievement. It was found that several educationally advantageous factors, such as smaller classes, increase the effect of SES on achievement. One ideal result that was not obtained in these models was to identify any school practices that raise achievement and do so to a greater extent amongst poor students. Such a result may not be realistic. A more conservative research question is therefore to ask which characteristics do raise achievement in the poorer section of the school system. What emerged from the HLM for African language schools in response to this question is regular homework, safety at school and younger teachers. The analysis using OLS also implied that reducing very large classes and overcoming severe problems with student absenteeism can be expected to improve achievement within the African language group of schools. The next chapter continues the search for school efficiency indicators that are linked to higher achievement within the historically disadvantaged system by analysing data from the National School Effectiveness Study (NSES). This dataset has several unique features, including a rich collection of school management information, which allow the analysis to be taken further.

CHAPTER 4: UNCOVERING INDICATORS OF SCHOOL FUNCTIONALITY IN SOUTH AFRICA[45]

4.1) Motivation for a deeper probe into school management and teacher quality effects

One reason to be interested in identifying characteristics of school management and teacher behaviour that are associated with student achievement is that the literature explaining schooling outcomes in South Africa has generally recognised that these factors are probably important but, due to data limitations, has been largely ineffective in pinpointing actual indicators.[46]

Van der Berg (2008: 153) argues that school resources do not necessarily make a difference but that the ability of schools to convert resources into outcomes is the crucial factor, and that this is where the policy attention is required. The ability to convert resources into outcomes is essentially what economists of education call school efficiency. However, this tradition of research is often unable to illuminate the specific organisational features or teaching practices which promote greater school efficiency. Large-scale sample surveys of educational achievement, which form the main source of information for education production function analysis, are not always designed for a developing country context and therefore do not adequately capture the salient aspects of school management practice in South Africa. Also, responses to questions put to teachers and principals tend to suffer from a systematic bias as respondents are likely to give themselves a more favourable appraisal than would reflect reality. Moreover, behaviour is likely to change upon observation. The result is that aspects of school practice such as time management may not come through significantly in modelling student achievement, even though such factors do indeed matter. School functionality or efficiency remains something of a "black box": resources flow into the box and differential outcomes emerge, yet little is known or can be proven about what occurs within the box to determine the outcomes.

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[45] This chapter draws on work done by the author for JET Education Services as part of the National School Effectiveness Study (NSES). The research has therefore benefitted from discussions including Nick Taylor, Thabo Mabogoane and Martin Gustafsson.

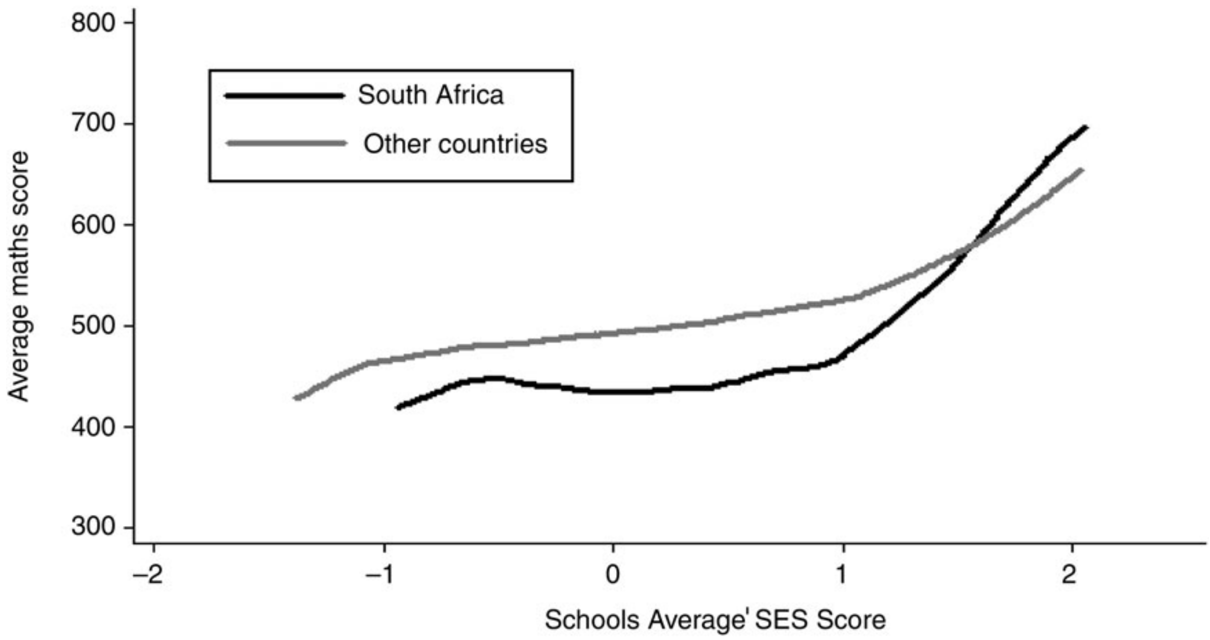
[46] This difficulty of demonstrating what aspects of management and teacher practice impact on student achievement mainly applies to large-scale studies aiming to make generalised conclusions. Hoadley (2010) summarises some of the key findings that have consistently emerged from medium and small-scale South African studies about what factors affect student achievement. These include appropriate assessment and feedback to students, teacher proficiency in the language of instruction, a focus on reading and written work and curriculum coverage, which is a function of teacher knowledge and planning (Hoadley, 2010: 22).

Van der Berg and Burger (2002), in their study of achievement in the Western Cape province, found that approximately two-thirds of the variation in achievement could be explained by SES, the racial composition of schools and a selection of teacher resource variables. They suggest that the efficiency of school management was probably an important omitted variable. Similarly, Crouch and Mabogoane (1998), combining the unexplained variation in their model with the effect of a dummy variable for historical education department (which they regard as capturing an efficiency dimension because SES was already controlled for in the model) estimate that approximately 50% of the variation in school performance is attributable to the unobserved feature of management efficiency. A production function study by Gustafsson (2007) did manage to identify the correct allocation of management and teaching time as one management level factor that was associated with achievement in South Africa.

Figure 4.1, which is taken from Van der Berg (2007: 857), can be regarded as suggestive evidence of the influence of unobserved school (dys)functionality that is hindering educational achievement in South Africa. The figure shows lowess regression lines of average school mathematics achievement against school mean SES for South Africa and for the other African countries in the SACMEQ II survey. The asset-based index for SES is comparable across all SACMEQ countries. The lowess line for South Africa lies below that for the other countries across most of the distribution. Only at the most affluent end of the distribution do South African schools enjoy a performance advantage. Van der Berg (2007: 857) concludes that poor South African children are performing worse than equally poor children in the other African countries in this sample – this despite favourable characteristics in South Africa in terms of pupil-teacher ratios, the availability of textbooks and teacher qualifications. The figure demonstrates that although SES has a strong influence on achievement in South Africa and elsewhere, there remains room for improvement at given levels of SES. Unobserved aspects of school functionality, management efficiency and teacher behaviour are surely leading candidates to underlie the gap in Figure 4.1.[47]

[47] Figure 4.1 from Van der Berg (2007) is analogous to Figure 3.17 in the previous chapter, which showed lowess lines for SACMEQ countries and South Africa, but for reading rather than mathematics. The same pattern emerged for reading, thus adding weight to the point that poor South African schools appear to be less efficient at achieving outcomes given the SES of their students, and that unobserved management characteristics may well underlie this inefficiency.

Figure 4.1: Lowess lines for South Africa and other SACMEQ countries



Source: Van der Berg (2007: 857)

Effective school management practice has thus proved hard to observe using large-scale sample surveys. This is evident in the review by Taylor *et al* (2003) of factors that have been shown to influence student achievement. They split their review into large-scale sample-based studies and small-scale descriptive studies. They group influential factors emerging from large-scale sample studies into the following categories: race, parent education, household income and wealth, settlement type, family structure, gender, language use and language of instruction, teacher qualifications, facilities, pupil-teacher ratios and learning materials. Absent from this list but present under the list of factors described by small-scale studies is management. Taylor *et al* (2003: 61) maintain that the task of management is to "provide an environment in which teachers can teach and students can learn." It is understandable that case study-type methodologies, which involve extensive observation and open-ended description, are better suited to capturing this management function than sample surveys, which rely mainly on closed-ended questions. The limitation of small studies, however, is that it is not possible to generalise from them conclusions that apply to the school system at large.

Further motivation for investigating school management more closely follows from the findings of the previous chapter. Dramatic differences in achievement were attributable to SES and to the historically different parts of the school system. Very few management indicators could, however, be found in the PIRLS dataset that were consistently associated with reading achievement amongst South African children. Class size did have consistent effects, and this variable, although ostensibly a resource variable, is also reflective of management practice, as was argued in the previous chapter.

Furthermore, a large amount of unexplained variation in reading achievement amongst African language schools remained in the restricted OLS and HLM models. It proved especially difficult to identify school and teacher characteristics that were significantly associated with achievement in this group of schools. One possible reason for this was offered by way of an agricultural analogy where normally beneficial treatments given to seeds do not produce growth if the soil itself is not fertile. Archer (1995: 16) expresses this same idea rather well: "some school systems operate so inefficiently that certain teaching tools, which under more optimal organisational conditions would yield achievement gains, fail to be utilised efficaciously." When this is the case, the use of education production functions can shift from searching for the optimal mix of school inputs and teaching methods to identifying indicators of organisational efficiency. An indicator is different from a school input in that it points to something else, such as the concept of management efficiency. The identification of such indicators requires more detailed information about school practices and teacher behaviour than is contained in the international surveys like PIRLS and TIMSS.

The next subsection argues that the data used in this chapter does indeed boast a richer collection of school and teacher variables as well as several other advantages that are unique in the South African context. Section 4.3 presents mainly descriptive analysis of student characteristics and their association with literacy and numeracy. In particular, the influence of SES at the student and peer level is described. Section 4.4 introduces some of the more interesting indicators of school and teacher quality that emerged from the extensive documentary reviews and interviews with teachers and principals. The predictive power of these quality indicators is more rigorously analysed in Section 4.5 using a variety of multivariate regression techniques. These models take the analysis of educational achievement further than those based on the PIRLS data in Chapter 3, due to the unique design of the NSES (which is discussed in the next sub-section).

4.2) The National School Effectiveness Study

4.2.1) The design of the survey

The National School Effectiveness Study (NSES) is the first large-scale panel study of educational achievement in South African schools. The project was administered by JET Education Services and funded by the Royal Netherlands Embassy. Students in 266 schools in eight of the nine provinces of South Africa were tested in both literacy and numeracy in grade 3 (2007).[48] A year later the same students were tested using the exact same literacy and numeracy test instruments.[49] Once the two waves had been matched, a panel dataset of 11,813 students was realised. In addition to the student tests, the other survey instruments were student questionnaires in 2007 and 2008, a teacher questionnaire in 2008 and school principal questionnaires in 2007 and 2008.[50]

The testing of the same students a year apart provides several distinct advantages over simple cross-sections of achievement such as those offered by TIMSS, PIRLS or SACMEQ. It is now possible to examine how much learning took place during a year of schooling. The availability of a pre-score improves the precision with which school effects can be estimated when using multivariate regression techniques. This is because it deals with the effects of unobservables such as the innate ability and motivation of students. This will be discussed in more detail at the outset of the multivariate modelling in this chapter.

A second advantage of the NSES is simply the extensiveness with which it covered school management, teacher knowledge and teacher practice issues. A wide variety of issues were surveyed and they were covered with remarkably fine detail for a large-scale sample survey. For example, an extensive document review was carried out including examining the frequency of various types of exercises in student workbooks. English teachers took a short literacy test and mathematics teachers took a short numeracy test, allowing the effects of teacher knowledge on student achievement to be investigated. The SACMEQ II survey had included this in its design, but South African teachers were exempt from taking the test, reportedly due to opposition from

[48] Unfortunately the project was blocked from surveying Gauteng due to other testing that was being administered in that province at the same time.
[49] A third wave was administered in 2009 testing the same students in their 5th grade. However, at the time of writing, the data cleaning of this wave was not yet complete.
[50] Information on the ex-racial department of schools was imputed from the DoE's Master List of Schools.

teacher unions. The third wave of SACMEQ did test South African teachers although this dataset had not yet released into the public domain at the time of writing.

4.2.2) Summary of literacy and numeracy results in the NSES

With data from two waves of literacy and numeracy tests, several potential outcomes of interest are available. Table 4.1 summarises the mean scores for literacy and numeracy in each year as well as the gain scores by gender, home language and quintiles of school mean SES.[51]

Table 4.1: Mean NSES results by gender, home language and School SES quintile[52]

	Literacy 2007	Literacy 2008	Literacy gain	Numeracy 2007	Numeracy 2008	Numeracy gain
Females	20.39	28.63	8.23	29.42	35.65	6.23
Males	18.27	25.28	7.01	27.33	33.41	6.08
African language	16.93	24.14	7.21	25.08	31.01	5.92
Afrikaans or English	32.75	42.81	10.06	46.62	54.08	7.46
School SES quintile 1	14.83	21.40	6.57	25.15	30.32	5.17
School SES quintile 2	15.90	22.16	6.26	26.15	29.44	3.29
School SES quintile 3	14.88	21.99	7.11	22.89	28.49	5.60
School SES quintile 4	17.53	24.92	7.39	22.99	30.39	7.40
School SES quintile 5	30.96	41.08	10.12	43.44	51.28	7.84
Total	19.38	27.03	7.65	28.42	34.58	6.16

The scores in the table are expressed as percentages. An initial observation is that the scores were rather low in general, especially considering that the difficulty level of the test questions ranged from grade 1 level to grade 4 level. The mean achievement in literacy in 2007 (grade 3) was 19.38%, which improved to 27.03% a year later. For numeracy the mean achievement increased from 28.42% in grade 3 to 34.58% in grade 4.

Several other patterns are evident in the table. On all the outcomes female students performed better than male students on average. Students whose home language was Afrikaans or English

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[51] An asset-based index for SES was derived for each individual. This is described in Section 4.3.2 to follow. The mean of SES in each school was then calculated and schools were subsequently divided into SES quintiles.

[52] A weight was specified to adjust for the sampling design in the analysis in this table, and in the forthcoming analysis when appropriate. The sampling used a one stage stratification design on the basis of province so that weights differed according to province but each student within a given province had the same weight.

performed considerably better than those whose home language was one of the other South African languages.[53] Two factors probably drive this difference. Firstly, the tests were administered in English, which would have afforded English speakers an understandable advantage.[54] One would expect this advantage to be reduced in grade 4 as the English ability of students in African language schools improves, but the gap appears to widen in grade 4 as seen in Table 4.1. Secondly, students who spoke Afrikaans and English came from more affluent homes (as measured by the asset-based index of SES) than African language students, and were located predominantly in historically white and coloured schools. Thus a socio-economic and school system effect also underlies the disparity in achievement by language. The outcomes were similar across the bottom four quintiles of school mean SES, and then significantly higher on average for the top quintile of schools. This reflects the presence of the elite group of historically advantaged schools within the top quintile. It is significant that in literacy, for example, the difference between the bottom and top quintile was less than half the size of the average improvement across the years. According to this measure, therefore, the educational backlog faced by poor students is equivalent to at least two years of learning.

Using box plots, Figures 4.2 and 4.3 depict the provincial breakdown of literacy and numeracy scores respectively. The thick bars extend from the 25th percentile to the 75th percentile of scores, with the median indicated somewhere between. Both figures depict a trend of moderate improvement across the two years. The Western Cape was the best performing province and also achieved a significant gain over the two years. It may be cause for concern that the Eastern Cape and the North West Province achieved negligible gains in numeracy. In contrast, KwaZulu-Natal, Mpumalanga and the Limpopo Province all demonstrated noticeable improvements although at very low levels of achievement.

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[53] Box plots of literacy and numeracy achievement for all 11 home languages are presented in Appendix H.

[54] The decision to administer all three waves of testing in the NSES in English was made because the language of learning and teaching (LOLT) in South African schools changes from the mother tongue in the Foundation phase (grade R-3) to English in grade 4. It therefore made sense to test in English at the grade 4 and 5 levels, and, for the sake of standardising the tests, they were also administered in English in the first wave (grade 3).

Figure 4.2: Literacy scores by province

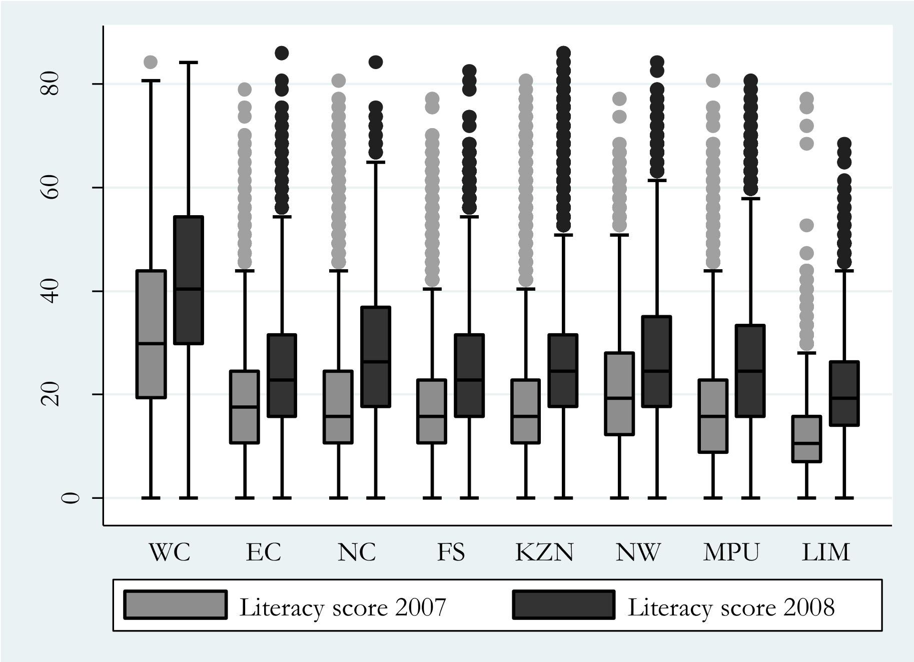
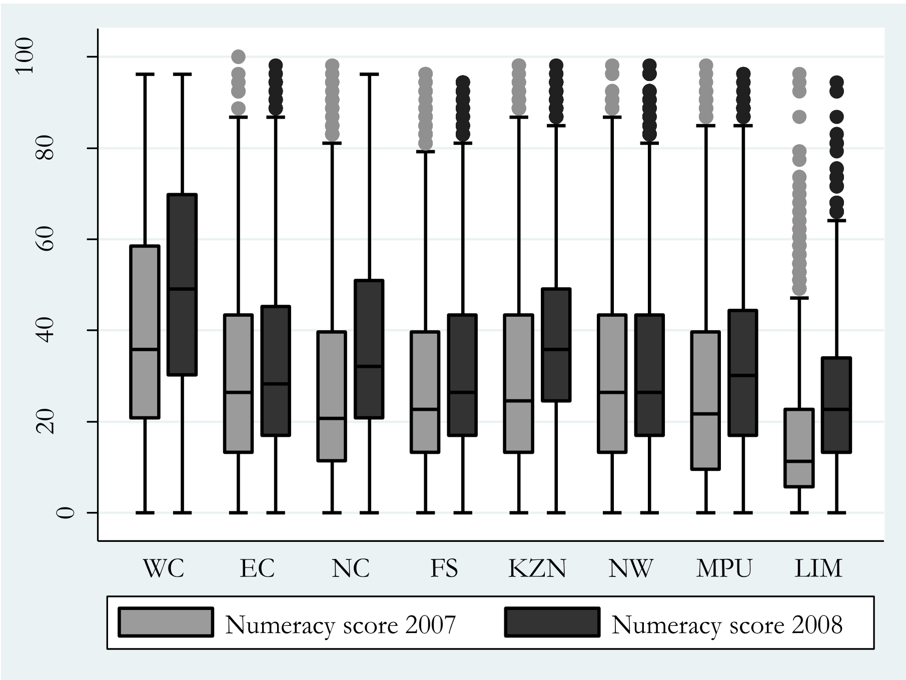


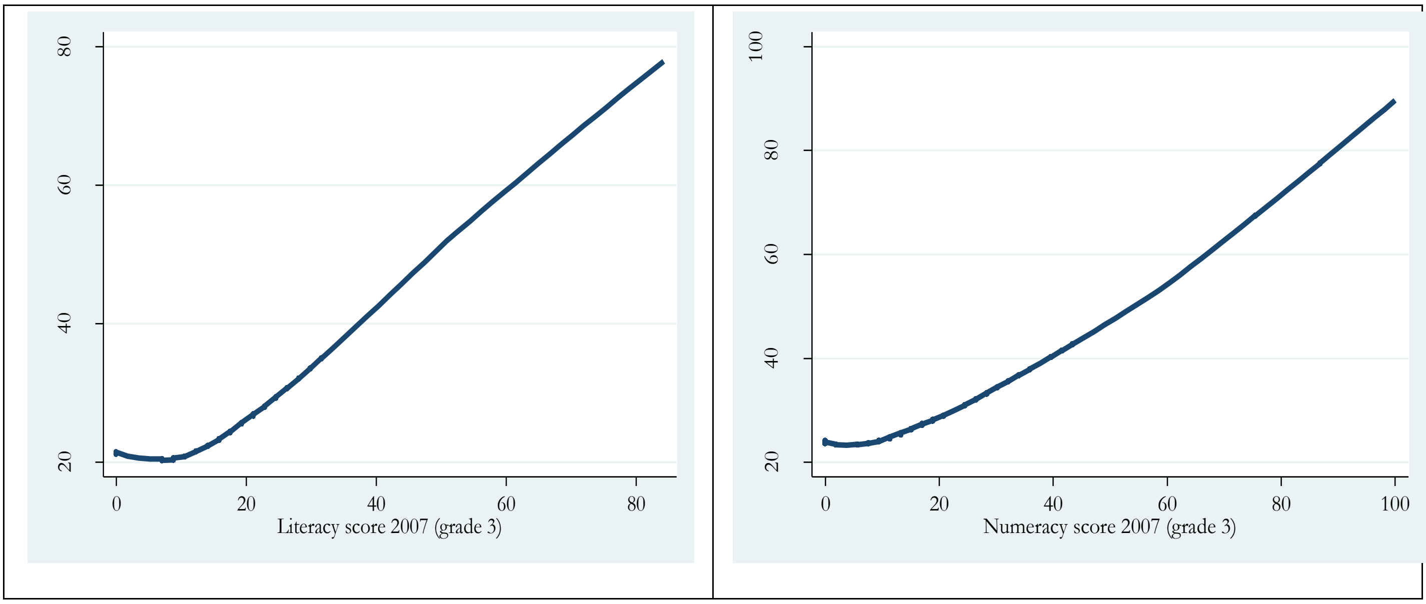
Figure 4.3: Numeracy scores by province



One statistical issue that should be noted when considering the gain scores in the NSES data is a phenomenon of regression to the mean. This phenomenon occurs in numerous types of data whenever there is a tendency for especially large or small measurements (far from the sample mean) to be followed by repeat measurements of the same units that are closer to the sample mean (Barnett, Van der Pols and Dobson, 2005: 15). In this case there is a tendency for especially low or high student scores in 2007 to be followed by scores of the same individuals that are closer to the mean in 2008. This happens because with each individual test score there is a degree of random error around a hypothetical true mean, which would accurately reflect the individual's true ability. If an individual were tested a sufficient number of times this true mean would become evident. A large proportion of the NSES tests were multiple choice questions. This means that the measurement error at the bottom end of test scores would be considerable. It is therefore likely that a very low score represents an underestimation of that individual's hypothetical true mean, and that a repeat test would yield a higher score even if no learning has taken place in the interim. This sort of regression to the mean would result in overestimation of gain scores at the low end of test scores and underestimation of gain scores amongst the high achieving students.

Figure 4.4 provides a visual test for regression to the mean. The figure shows lowess regression lines of 2007 scores against 2008 scores for literacy (in the first panel) and numeracy (in the second panel). The flat, and even somewhat downward sloping, parts of the lines at the low end suggest that some regression to the mean may have occurred. For students with very low scores in 2007 (including zero), the 2008 score predicted by the lowess regression was around 20%. There was no difference in the predicted score for 2008 for those who scored zero and those who scored 10% in 2007. For these students, it is likely that their 2007 score was an underestimation of their true ability.

Figure 4.4: Visual test for regression to the mean



The correlation between literacy 2007 scores and literacy 2008 scores was 0.66. When students who scored 3% or less in 2007 were excluded, this correlation coefficient increased to 0.70. For numeracy this figure increased from 0.67 to 0.70. This further confirms that regression to the mean occurred to some extent at the bottom end of the distribution. One way to reduce any bias caused by regression to the mean is to exclude very low scores from the analysis. For several reasons this was decided against. First, this exclusion would decrease the effective sample size by about 1000 observations. Second, for much of the analysis presented in this chapter the sensitivity of the results to excluding very low scores was tested and it was found that the gist of the results remained largely unchanged. Third, a factor other than regression to the mean may also underlie the extremely low scores registered in 2007. As students were in grade 3 in 2007 the language of learning and teaching (LOLT) would have been their home language. Most of these students would therefore probably have had very little or no experience in being tested in English. This may account for the substantial number of students scoring zero or close to that in the first wave of literacy and numeracy tests.

For these reasons no attempt to control for regression to the mean was made in the forthcoming analysis. However, it is something to be aware of when interpreting patterns at the very low end of achievement.

4.3) Student characteristics and the influence of SES

4.3.1) Descriptive analysis of selected aspects of home background

One aspect of student home background which is known to have strong racial and socio-economic dimensions and to be associated with educational outcomes, is family structure (Anderson *et al*, 2001). Figure 4.5 shows the percentages of students in the NSES with no parent, a single parent and both parents present at home by home language. It is evident that Afrikaans and English speaking students were most likely to have both parents at home and least likely to have none. There was probably a mix of race groups amongst those students with a home language of English or Afrikaans. Differences in family structure are likely to be even starker by race. According to the General Household Survey of 2006, 31% of black children between the ages of ten and twelve lived in a household with neither parent present, 41% of black children lived with a single parent and only 28% lived with both parents present. In contrast, 80% of white children and 89% of Indian children between ten and twelve lived with both parents present (calculated from the General Household Survey, 2006).

Figure 4.5: Family structure by home language

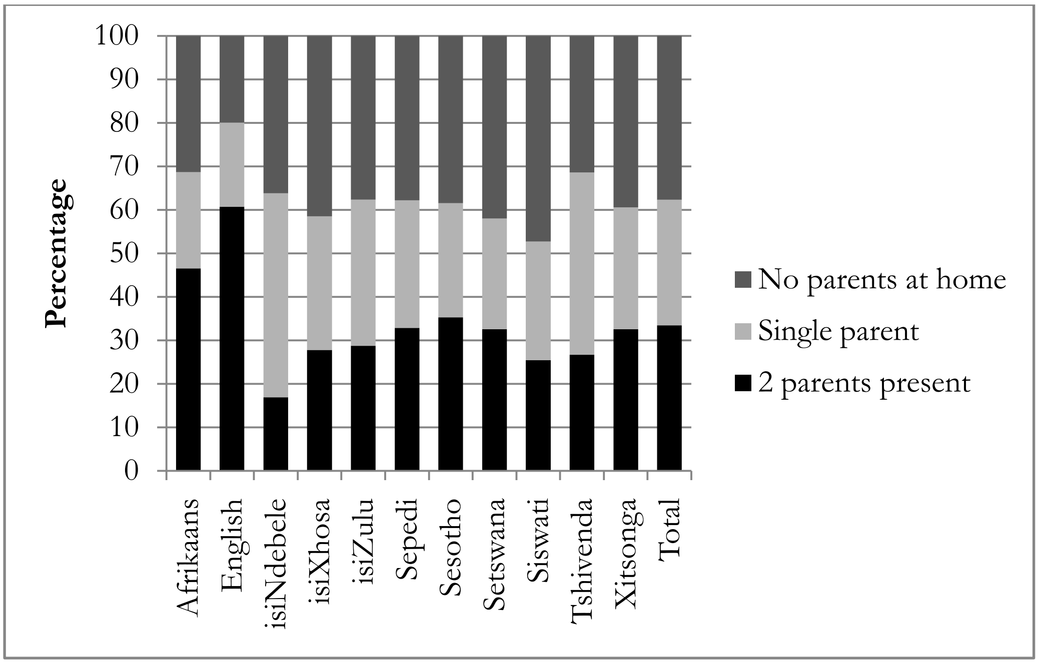


Table 4.2 reveals an interesting pattern when looking at average achievement by family structure and home language. For Afrikaans and English speaking students there are noticeable achievement gaps between those with no parents, a single parent and both parents. A race issue may be driving this pattern to some extent as single parent households are more common in coloured communities than in white communities. In contrast, amongst African language students average achievement in literacy and numeracy is similar for those of different family structure. At least two explanations for this might hold. It could be that the quantity and quality of parental support offered by African language parents are insufficient to substantially affect achievement. Alternatively, this pattern could reflect that most African language students are in schools with such a low level of functionality that parent support is unable to bring about a significant improvement in achievement. This latter possibility motivated the production of Table 4.3, which is the same as Table 4.2 but excludes students in historically black schools.

Table 4.2: Literacy and numeracy achievement by family structure and home language

Number of parents present	Literacy 2008		Numeracy 2008	
	African language	Afrikaans/English	African language	Afrikaans/English
0	23.72	35.81	30.76	44.34
1	24.21	39.98	31.63	50.37
2	24.61	47.23	30.70	60.13
Total	24.14	42.81	31.01	54.08
Number of students	9740	2048	9740	2048

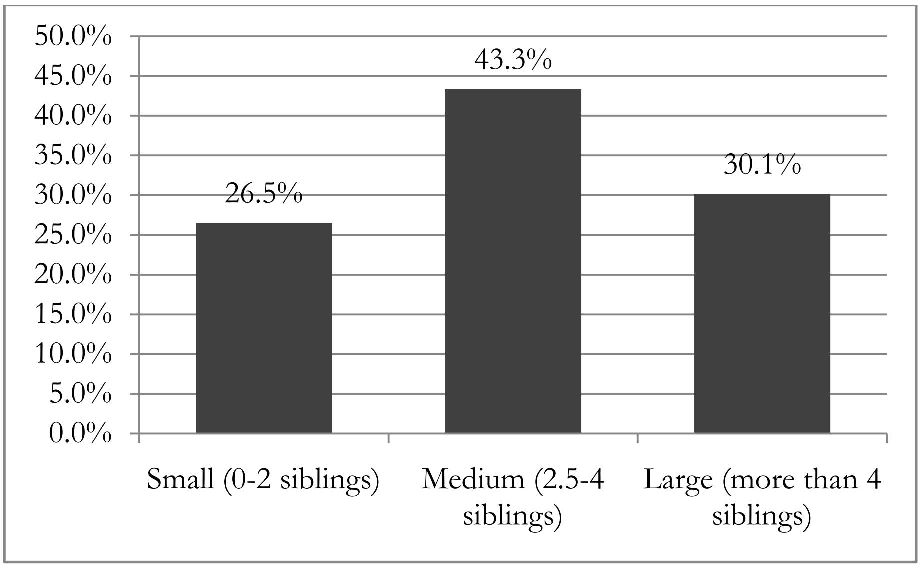
Table 4.3: Literacy and numeracy achievement by family structure and home language excluding historically black schools

Number of Parents present	Literacy 2008		Numeracy 2008	
	African language	Afrikaans/English	African language	Afrikaans/English
0	35.88	38.60	47.25	47.50
1	43.66	42.56	56.69	53.51
2	44.13	49.05	57.71	62.49
Total	41.05	45.23	53.68	57.08
Number of students	630	1787	630	1787

Table 4.3 shows that African language students in historically white, coloured and Indian schools perform at a level much closer to that achieved by Afrikaans and English students. Moreover, family structure now appears to be associated with achievement for African language students. This supports the hypothesis that school functionality and parental support interact to influence achievement, and that low functionality in the historically black part of the system may be prohibiting parent support from being effective. However, this does not rule out the possibility that the quality of parental support is also driving this pattern as African language parents who value education, are themselves relatively well educated and therefore able to provide effective educational support, are likely to send their children to the better-performing historically white, coloured and Indian schools.

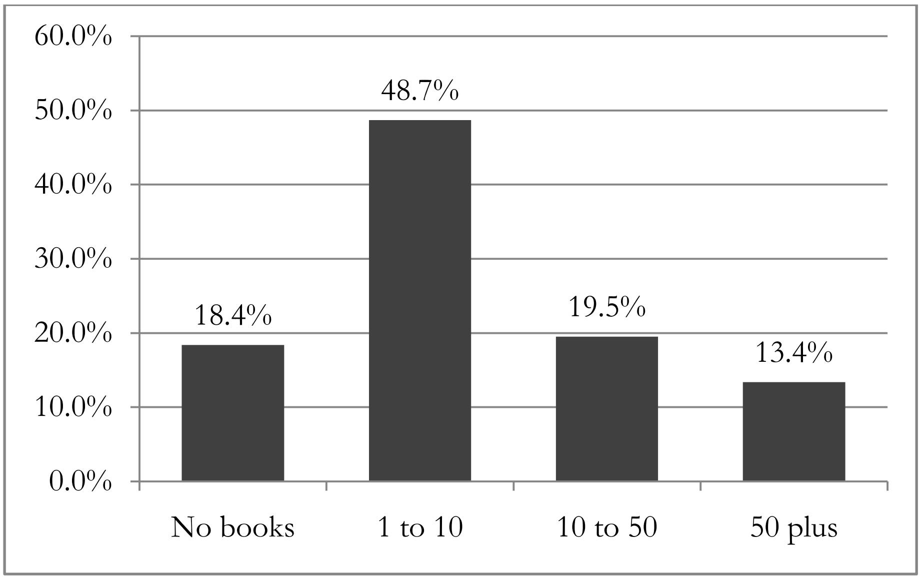
Household size as measured by the number of siblings is another aspect of home background that was surveyed and was inversely associated with achievement including in the multivariate analysis, which is presented in Section 4.5. Figure 4.6 depicts the proportion of students falling into various categories of household size.

Figure 4.6: Household size (number of siblings)



Numerous questions concerning the availability of educational resources and support at home were included in the student questionnaire. The number of books at home is often considered a good indicator of educational resources in the home. Figure 4.7 describes the numbers of books that were reportedly present in students' homes. The majority of students reported having fewer than 10 books at home. It should be noted that in the multivariate analysis this variable was very sensitive to the model specification and was not always significantly associated with achievement. This does not imply that it is an unimportant factor. It may be that its effect was picked up by other explanatory variables such as student SES.

Figure 4.7: Number of books at home



The NSES captured information regarding the frequency of exposure to English through several means. Students were asked how often they speak English, how many times per week they hear English on television and how often they listen to English on the radio. Table 4.4 shows the proportion of students who reported being exposed to English through speaking and through the television at least 3 times a week, first for those whose home language was not English and then for those whose home language was English. Exposure to English through listening to the radio is not presented here as this variable was not consistently associated with literacy or numeracy achievement. As one might expect, frequent exposure to English was more common amongst those whose home language was English. The figure of 85% was probably an under-capturing of the exposure to English for those whose home language was English.

Table 4.4: Exposure to English through speaking and television by home language

	Speak English 3 or more times per week	English on TV 3 or more times per week
Home language not English	9%	44%
Home language English	85%	74%
Total	13%	45%

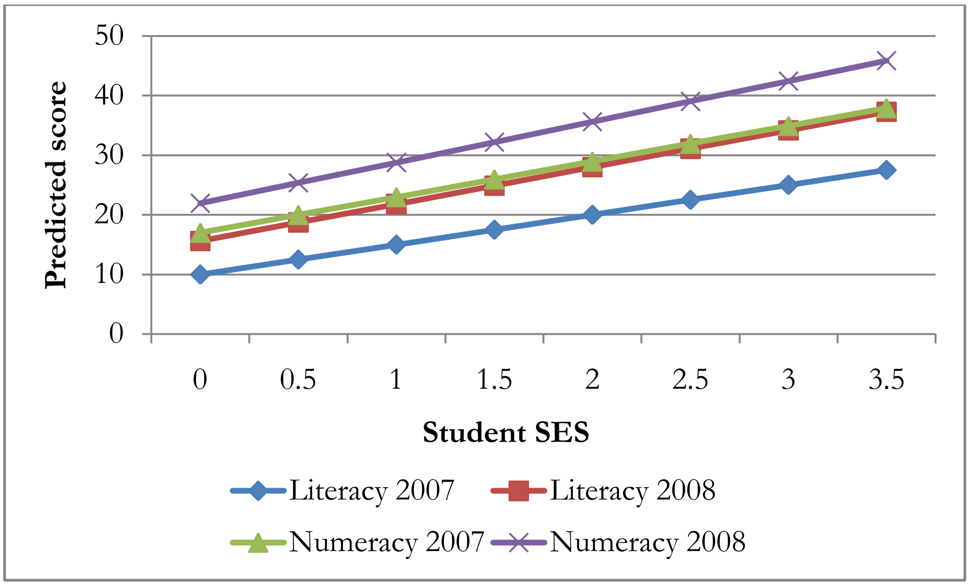
The home level characteristics described here are only a sample of the information collected in the student questionnaire. This questionnaire also contained several questions that were suitable to be used in the compilation of an index for student SES. This is discussed next.

4.3.2) The influence of SES

The student questionnaire in the NSES asked students about the presence of a number of household items at their homes. Students were asked about the presence of a fridge, tap water, a toilet, electricity, a car, a computer, a newspaper and a washing machine. PCA was applied to these in order to derive appropriate weights for each variable in an SES index. This is exactly the same technique that was used to derive an SES index in Chapter 3, as explained in Section 3.3. The index was standardised to have a minimum value of zero and a standard deviation of 1. The mean of SES within each school was also derived in order to capture the overall SES of each school.

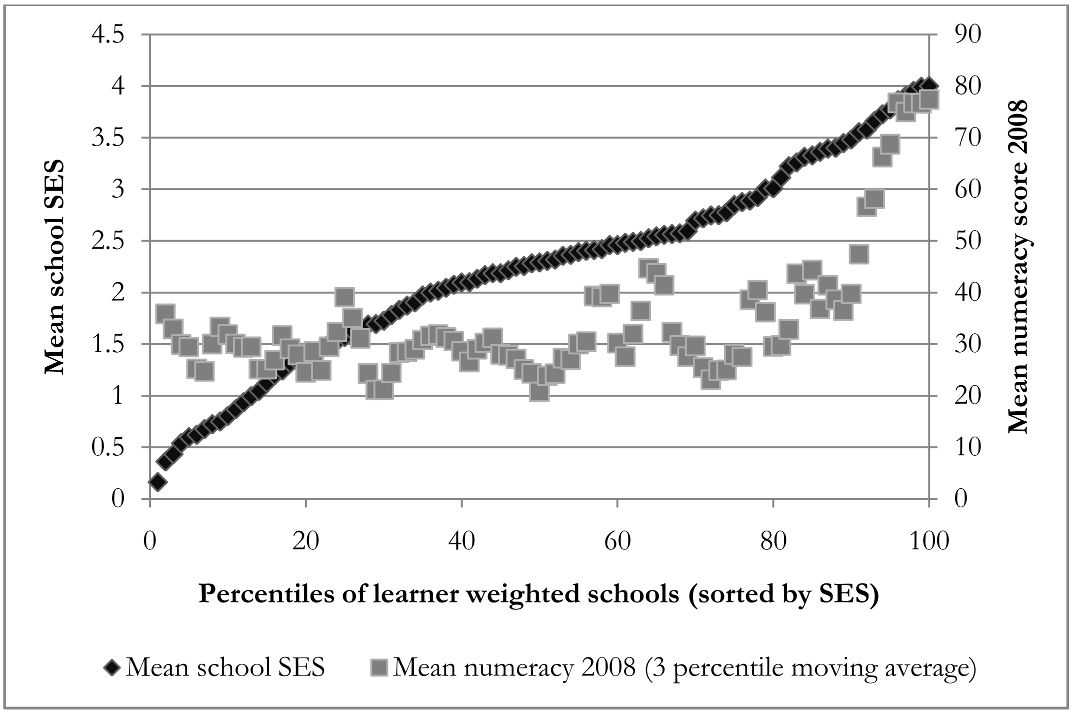
Figure 4.8 presents the basic linear socio-economic gradients of the same sort that were estimated using the PIRLS data in the previous chapter. Gradients for all four outcomes are presented. The heights of the lines differ somewhat due to the higher achievement in 2008 than 2007 and due to the fact that scores were higher for numeracy than for literacy. The slopes of the various lines are essentially similar, although the lines for numeracy are somewhat steeper than for literacy. A one standard deviation increase in SES was associated with an increase in the numeracy 2008 score of 6.81% whereas for literacy 2008 an increase of 6.23% was found.

Figure 4.8: Basic socio-economic gradients for literacy and numeracy in both years



The association of the mean SES within each school with achievement is depicted in Figure 4.9 by means of a percentile plot. The figure shows a percentile plot of both school mean SES and numeracy score in 2008 (grade 4). Note that in the plot schools are ranked into percentiles of mean school SES and that three percentile moving averages are presented in order to smooth the curve somewhat. The figure reveals that the relationship between numeracy achievement and school SES is pretty much flat amongst the bottom 80 percentiles. Only amongst the most affluent 20% of schools does numeracy achievement start to rise, and then dramatically so. This reflects that the historically privileged and still well-performing schools are located in this top bracket.

Figure 4.9: Percentile plot of mean school SES and numeracy score 2008



Another preliminary way to analyse the influence of SES is to run an OLS regression predicting achievement based only on student SES and the mean SES in each school. Including both student and school SES allows one to assess the relative importance of these two factors. Table 4.5 reports the regression statistics for such a regression predicting literacy achievement in grade 4. Note that the inclusion of the squared and cubed versions of mean school SES was motivated by the sharp increase in the effect of SES on achievement at higher levels of SES that was evident in Figure 4.9, and was justified by this third order specification providing a better model fit than either a linear or quadratic specification.

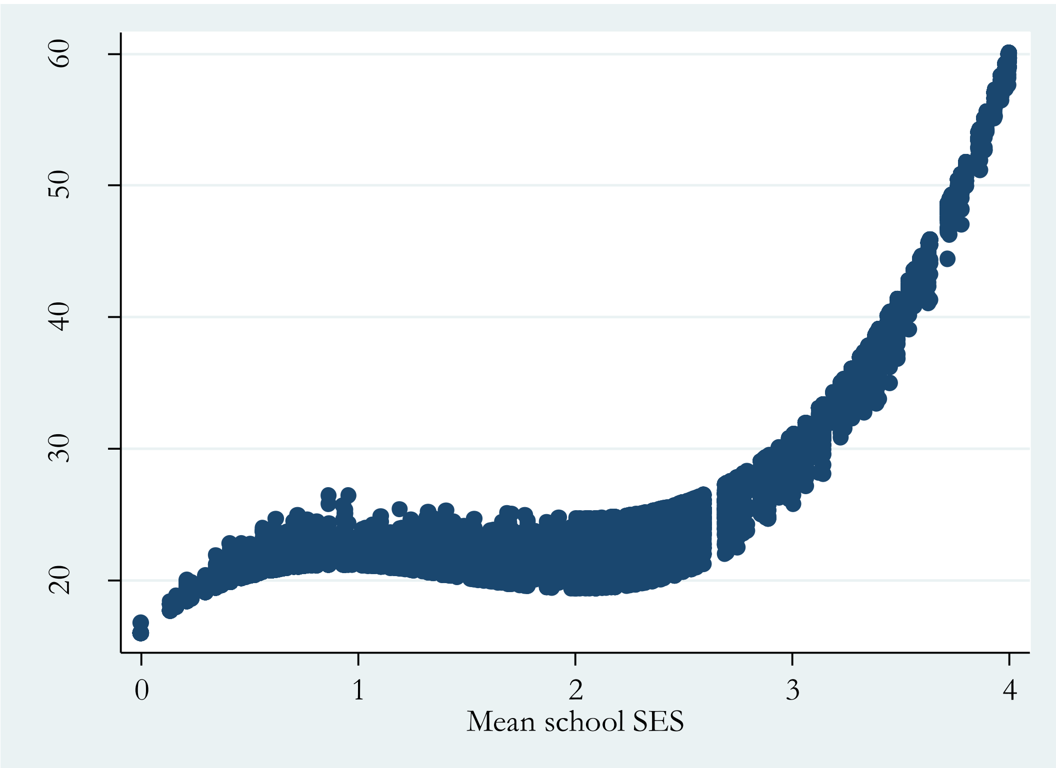
Due to the third order specification of school mean SES the coefficients reported in Table 4.5 are easier to interpret through graphing the results. Figure 4.10 depicts the predicted literacy score in 2008 according to the regression in Table 4.5. Movements along the horizontal axis represent changes in school mean SES, while the vertical width of the band of predicted values is due to variation in student SES while school mean SES is held constant. It is evident that variation in student SES at given levels of school mean SES was associated with fairly small changes in the predicted literacy achievement, whereas a movement to the top end of the school SES spectrum was associated with a very substantial increase in the predicted literacy score. It can therefore be said that the SES of a school has a more telling impact on student achievement than the student's own SES, although the latter may well determine what type of school students are able to attend.

Table 4.5: The effect of SES on literacy scores: student level and school level combined

Dependent variable: Literacy score 2008	
Mean School SES	13.44***
	(1.46)
Mean school SES squared	-10.81***
	(0.75)
Mean school SES cubed	2.47***
	(0.11)
Student SES	1.51***
	(0.17)
Constant	16.03***
	(0.81)
R-squared	0.38
N	11813

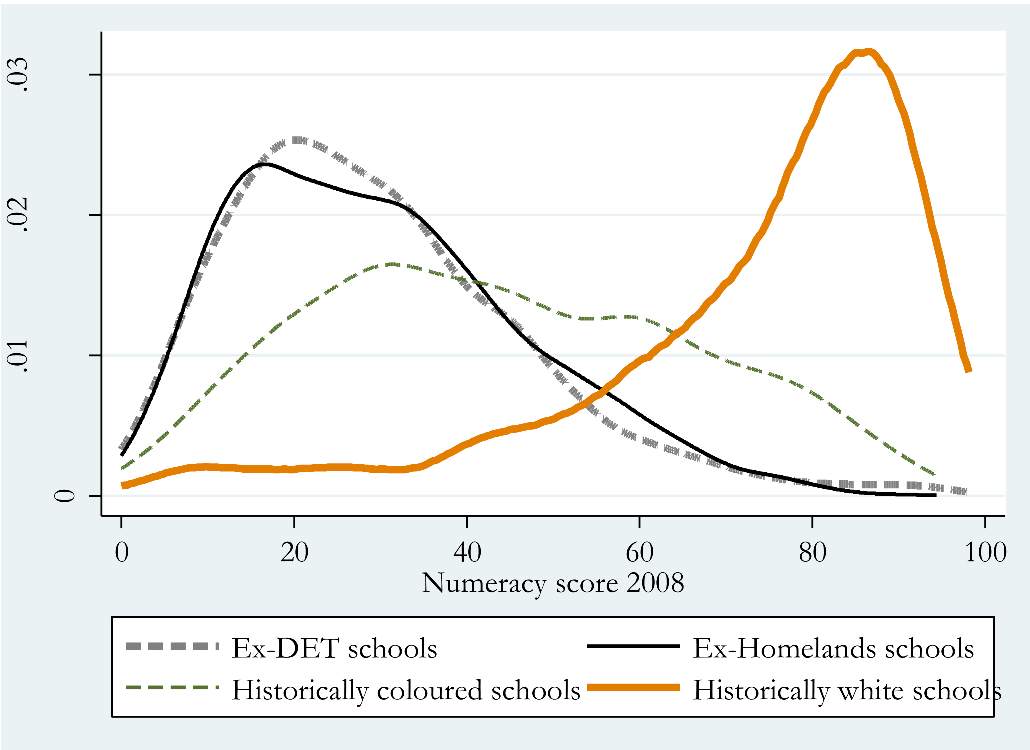
* p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parenthesis)

Figure 4.10: SES gradient for literacy: School SES combined with student SES (based on Table 4.5)



As considered at some length in chapter 3, the influence of SES on achievement in South Africa is intertwined with the historical divisions in the governance of schools on the basis of race. The former education department of schools was not indicated in the PIRLS data and so the language in which schools chose to take the test was used as a proxy for this. It was, however, possible to identify the former department for the schools in the NSES, as discussed earlier in this chapter. Figure 4.11 presents kernel density curves of numeracy achievement in grade 4 by former education department. In many of the rural parts of South Africa historically black schools were under the administration of the so-called homelands governments. Schools for black children in the rest of South Africa were administered by the Department of Education and Training (DET). The distributions of achievement for these two groups of schools look very similar, as Figure 4.11 suggests. The distribution for historically coloured schools is concentrated at a somewhat higher level and displays considerable variance. The distribution for students in historically white schools lies dramatically to the right. This figure clearly demonstrates what has been described as the "bimodality" of educational achievement in South Africa (e.g. Fleisch, 2008).

Figure 4.11: Kernel density curves of numeracy achievement by historical education department



Note: No kernel density curve is shown for students in historically Indian schools due to small sample size.

During the years since these historically different parts of the school system were brought under a single administration, there has been some migration of black students into historically white, coloured and Indian schools, although not in the opposite direction (Soudien, 2004). Figure 4.12 compares the achievement of African language students in historically black schools with African language students in historically white schools. It is clear that those in historically white schools are performing at a much higher level on average. Although it is mainly an elite black middle class that attends historically white schools, Figure 4.12 is surely also indicative of a different level of school effectiveness that is present in these two systems. To analyse this further requires multivariate analysis that also controls for individual SES of students in the different parts of the school system. Thus, simple OLS regressions were estimated, predicting the literacy and numeracy achievement of students whose home language was not English or Afrikaans, conditional upon student SES, mean school SES and former department. The results are reported in Table 4.6 and the predicted values for those in historically white and historically black schools are plotted in Figure 4.13.

Figure 4.12: Kernel density curves of numeracy achievement for African language students by historical education department

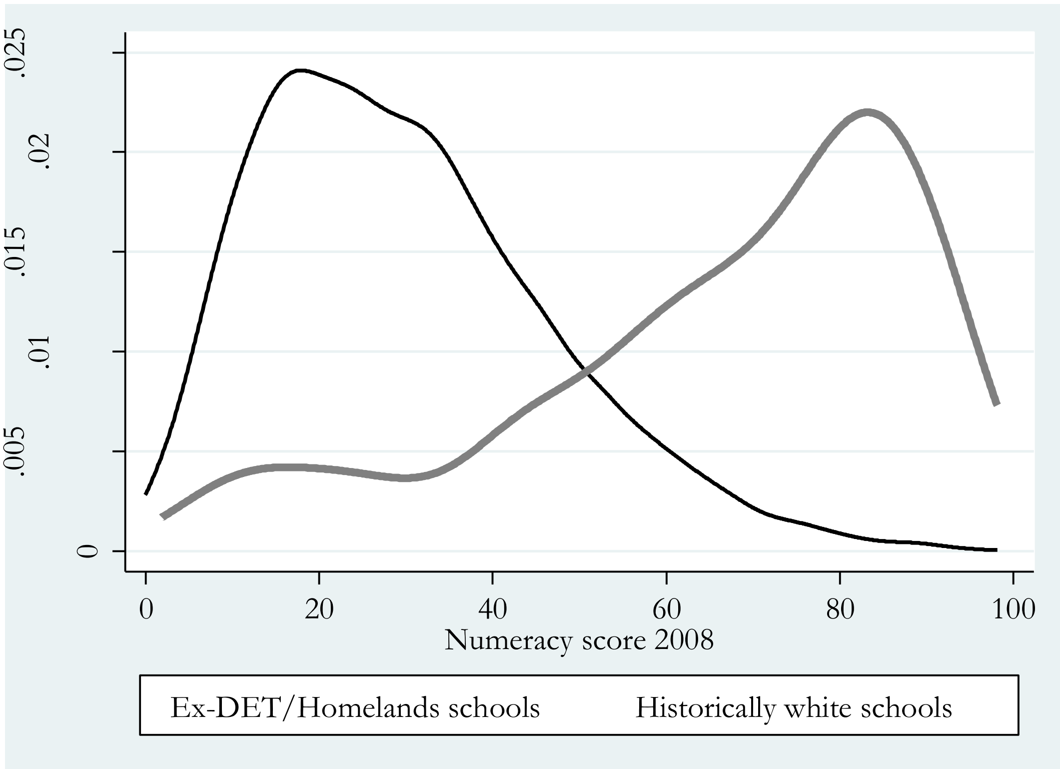


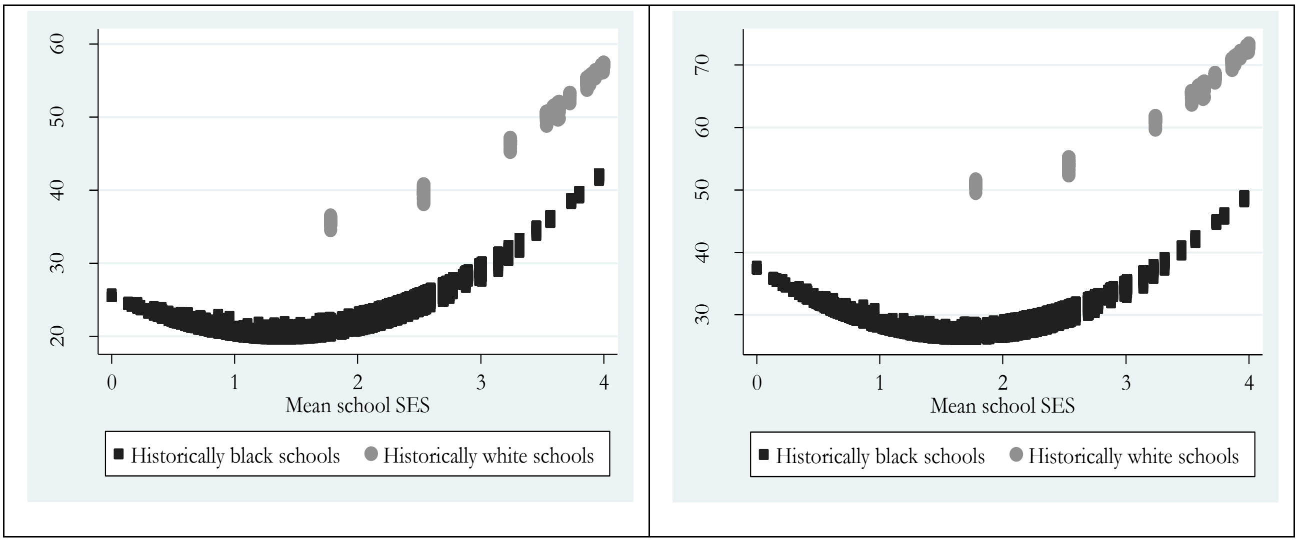
Table 4.6: OLS regressions predicting literacy and numeracy achievement for African language students by historical education department

Explanatory variables	For Literacy 2008	For Numeracy 2008
Student SES	0.74*** (1.56)	0.81*** (0.24)
Mean School SES	-8.41*** (2.45)	-13.40** (4.49)
Mean School SES squared	3.03*** (0.75)	3.95** (1.32)
HOR (C)	0.14 (1.41)	1.88 (2.30)
HOD (I)	6.38 (5.16)	13.50* (5.53)
HOA (W)	14.54** (4.64)	23.56** (7.56)
Constant	25.42*** (1.75)	37.39*** (3.48)
R-squared	0.2100	0.1414
Observations	9740	9740

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Note: Standard errors in parentheses

Figure 4.13: Predicted literacy and numeracy achievement for African language students by historical education department



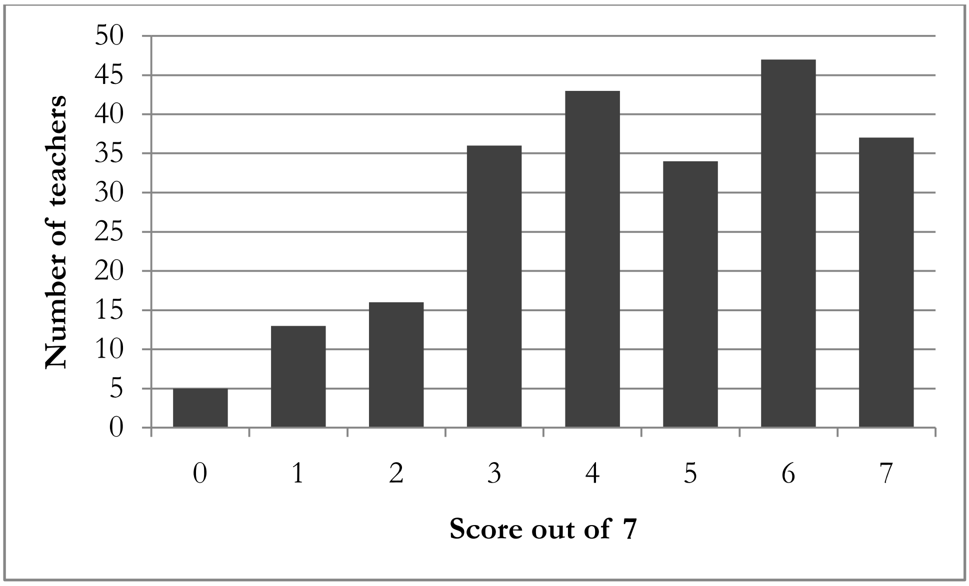
The table and figures demonstrate that even when controlling for student and school SES, African language students in historically white schools enjoy a considerable performance advantage over those in historically black schools. This difference is statistically significant and large, especially so in the case of numeracy. It is clear from this analysis that although achievement is strongly connected with student SES, much of this connection has to do with the effectiveness of schools in which students are located.

The next section describes several school and teacher characteristics captured in the NSES that can be considered indicators of quality.

4.4) Indicators of school and teacher effectiveness

Teacher knowledge has rarely been measured in large-scale sample surveys of student achievement in South Africa. The NSES administered a comprehension test with 7 questions to English teachers and a 5-mark test for mathematics teachers. The shortness of these tests means that they provide limited measures of teacher knowledge, but this feature does at least allow for the analysis to be taken one step further than before. Figure 4.14 shows a histogram of scores on the English teacher test. The histogram is skewed to the right indicating that most of the scores were concentrated at the higher end. Although there were few extremely low scores, there was still a lot of variation in teacher knowledge and only 16% of teachers scored 100%.

Figure 4.14: Histogram of English teacher test scores



An extensive review of student workbooks yielded several interesting indicators of curriculum coverage and the amount and type of work being done by children throughout the year. Figure 4.15 provides an indication of the amount of extended writing (defined as half a page or longer) that is undertaken by grade 4 students in South African schools. In a large number of cases this information was unspecified. Some of these may have been situations where the student workbooks were unavailable, but it is unclear what an unspecified response signifies in cases where other information from student workbooks was recorded. In 110 of the remaining 160 English classes no evidence could be found of extended writing. In only 18 classes could it be observed that students had engaged in extended writing at least four times in the year.

Figure 4.15: Frequency of extended writing exercises in student workbooks

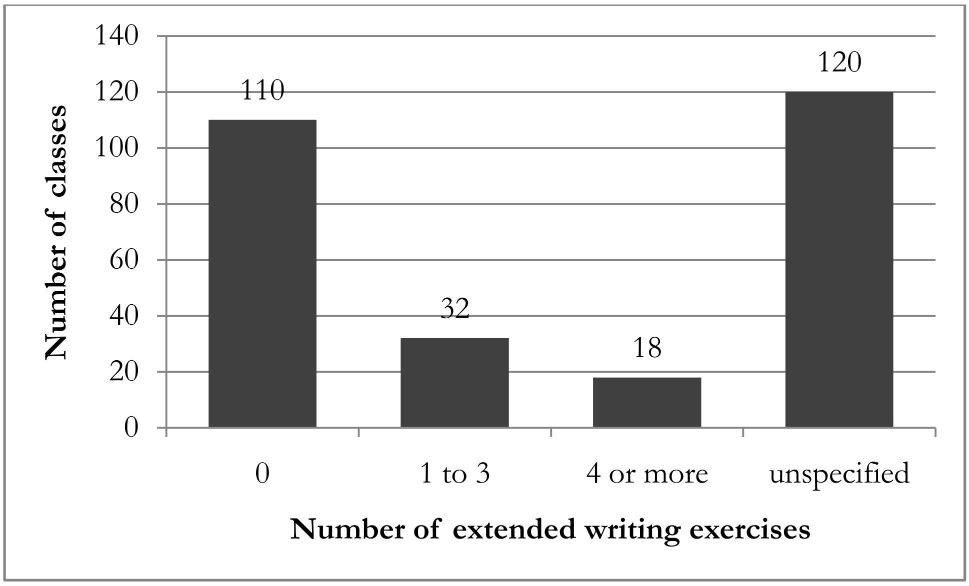


Figure 4.16 shows the number of teachers achieving each score out of five on the mathematics test. Most of the scores are in the middle range with only 29 teachers scoring 100%. The significance of this is better realised by looking at the distribution of mathematics teacher knowledge at the level of students, i.e. the numbers of students taught by teachers with each test score. Table 4.6 presents this breakdown. The table reveals that more than half of the students in this survey were taught by teachers who scored 40% or less on the simple mathematics test. Just over 12% of students were taught by teachers who scored 100%. It is not surprising that the achievement of South African students is so low given that teacher knowledge appears to be deficient in many of our schools. The far right column of Table 4.6 shows the mean numeracy achievement in 2008 (grade 4) for students in each category of teacher test score. For teachers who scored anything less than 100% the mean achievement of students was very similar. However, those students taught by teachers who scored 100% performed noticeably better than the rest. This suggests that more effective teachers have sound knowledge, or at least knowledge that is sound enough to achieve 100% on this short test. In contrast, any score less than 100% is an indicator of lower teacher quality and is linked to low student achievement. However, this assertion needs to be tested using multivariate analysis as teacher knowledge may well be

correlated with other aspects of school quality and with school mean SES, and these factors could be driving the pattern in Table 4.7. An example of the questions in the mathematics teacher test is also provided below.

1. 10 days 75 hours can be written as .... days .... hours

Figure 4.16: Histogram of Mathematics teacher test scores

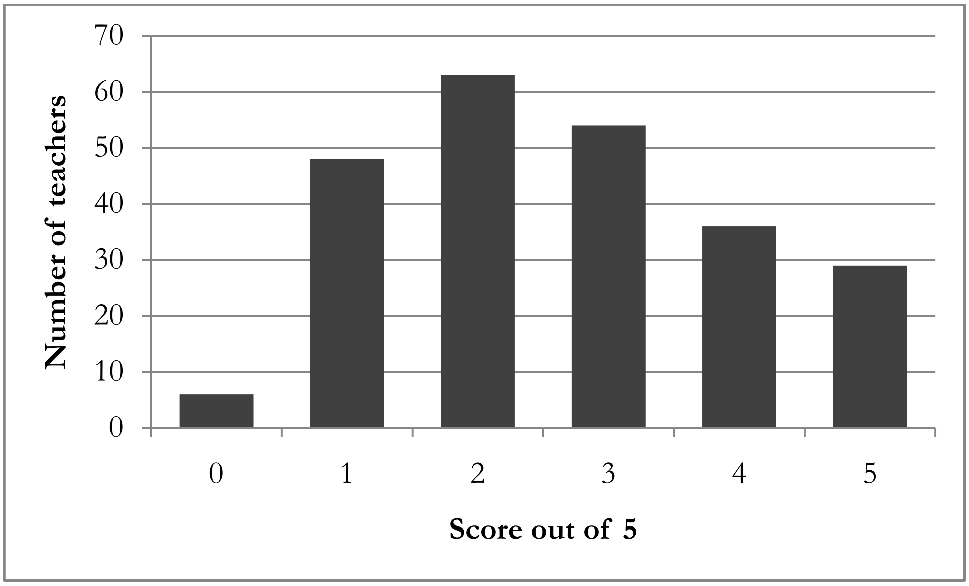


Table 4.7: The number and performance of students by teacher knowledge

Teacher score	Number of students	%	Cumulative %	Mean Numeracy 2008
0	210	2.12	2.12	37.27
1	2130	21.52	23.64	33.04
2	2774	28.02	51.66	33.50
3	2168	21.9	73.56	34.14
4	1408	14.22	87.79	34.77
5	1209	12.21	100	46.92
Total	9899	100	100	35.44

Another teacher characteristic captured in the NSES was the self-reported number of hours spent on actual teaching per week. This variable itself was not strongly correlated with student outcomes, although an interesting interaction between the time spent on teaching and teacher knowledge was noted.

Teachers were asked to estimate the number of hours they spent per week during school hours on actual teaching. As Table 4.8 demonstrates, students taught by teachers who scored less than 100% in the mathematics test and who reportedly taught for less than 18 hours per week had lower numeracy achievement in grade 4 on average than students with any other combination of these two teacher characteristics. Students taught by teachers with either better knowledge or more time spent teaching but not both of these characteristics performed somewhat better than the poorest performing group. However, students whose teachers scored 100% and reportedly spent more than 18 hours teaching performed substantially better on average than the other students. Table 4.9 demonstrates that not only did this category of students perform at a higher level, but they also showed the greatest improvement from one year to the next. This is an exciting finding as it suggests that it is only when teacher knowledge is combined with time on task that substantial student learning can be expected to occur.

Table 4.8: Means and frequencies of Numeracy achievement 2008 by teacher knowledge and time spent teaching

	Teacher score <100%	Teacher score 100%	Total
Less than 18 hours spent teaching	30.06 (3274)	34.84 (446)	30.64 (3720)
More than 18 hours spent teaching	36.13 (5416)	53.98 (763)	38.33 (6179)
Total	33.84 (8690)	46.92 (1209)	35.44 (9899)

Table 4.9: Means and frequencies of Numeracy gain score by teacher knowledge and time spent teaching

	Teacher score <100%	Teacher score 100%	Total
Less than 18 hours spent teaching	5.67 (3274)	5.01 (446)	5.59 (3720)
More than 18 hours spent teaching	7.07 (5416)	10.64 (763)	7.51 (6179)
Total	6.54 (8690)	8.56 (1209)	6.79 (9899)

Again, a word of caution regarding the interpretation of Tables 4.8 and 4.9 is necessary. It is likely that most of the more affluent of schools are located in the cell for "teacher score 100%" and "more than 18 hours spent teaching". Therefore, a multivariate analysis conditional upon SES is needed to test whether these teacher characteristics directly affect learning or whether they are better understood as indicators of the type of advantageous characteristics and practices that are present in the better-functioning part of the school system.

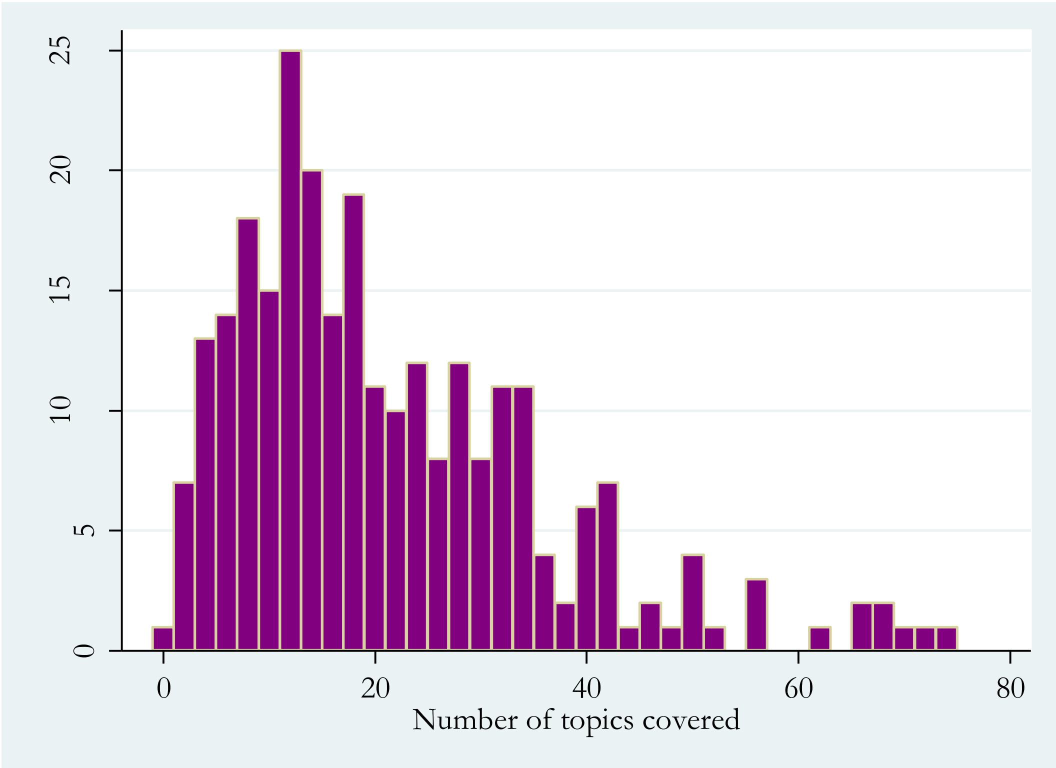
Another interesting indicator of mathematics teaching quality is the frequency of complex exercises found in student workbooks. Essentially, a complex exercise was defined as an exercise consisting of more than one step. Table 4.10 shows the numbers of students and teachers in the various frequency categories. Nearly 22% of students in the NSES were in classes where no evidence of any complex mathematics exercises could be found. Only 12% of students were in classes where more than 18 complex mathematics exercises had been completed during the year up to that point.

Table 4.10: The frequency of complex mathematics exercises in student workbooks

Number of complex exercises	Number of students	Percentage of students	Number of teachers
0	2586	21.89	69
1 to 4	3497	29.50	74
5 to 18	3016	25.54	73
more than 18	1429	12.09	41
unspecified	1285	10.88	23
Total	11813	100	280

Student workbooks were also examined to identify the number of mathematics topics (as specified in the curriculum) that had been covered up until that point in the year. Fieldworkers were looking for the 85 topics that are specified in the Revised National Curriculum Statement for grades R-9. Schools should have covered most of the curriculum by the time of the survey, although it is unlikely that exercises corresponding to all 85 topics would be identifiable in the workbooks of even the very best schools. This variable, therefore, represents a rough estimate of curriculum coverage. Figure 4.17 indicates that in most classes a fairly low number of topics had been covered, at least according to what was evident in student workbooks. Fewer than 10 topics had been covered in approximately 24% of classes (for which information on this variable was available), which suggests that only a small proportion of the curriculum was covered in these classes. One in three classes had covered more than 25 topics according to student workbooks.

Figure 4.17: The number of mathematics topics identified in student workbooks



Another variable which is (at least anecdotally) known to be an issue in many of South Africa's schools but which has rarely been effectively linked to student achievement is teacher absenteeism. The NSES captured the number of teachers absent on the day of the survey. Taking this value as a proportion of the total number of teachers at each school it is possible to derive the percentage of teachers absent on the day of the visit. This is by no means an accurate assessment of teacher absenteeism over the full year, but it is at least one hard indicator of teacher absenteeism. Table 4.11 presents the interaction between the proportion of teachers absent on the day of the visit and the state of teacher attendance registers. The state of attendance registers says something about the organisational efficiency within schools and also reflects of how seriously teacher attendance is taken by the school management. The table demonstrates that teacher absenteeism was approximately twice as high in schools where the teacher attendance register was not up-to-date.

Table 4.11: Teacher absenteeism by state of teacher attendance register

	Percentage absent	**Number of**
Register not up-to-date	20.50	51
Register up-to-date	10.19	191

The documentary review also assessed the quality of inventories for textbooks and other learning support materials in schools. This provides another indicator of the organisational efficiency within schools. Table 4.12 shows how student performance was associated with the presence and quality of LTSM inventories. It is evident that students in schools where inventories were both available and up-to-date performed better and achieved the highest gains from grade 3 to grade 4. This may mean that good management of school resources positively affects learning or that efficient management of learning materials is a sign of a good school. A combination of both of these possibilities may also underlie the association evident in Table 4.12. For this variable, as for many others discussed in this section, a better assessment of its impact is achievable through multivariate analysis. This is the focus of the next section.

Table 4.12: Student performance by state of school LTSM inventories

	Mean numeracy 2008	**Mean numeracy gain**	**Mean literacy 2008**	**Mean literacy gain**	**number of schools**
No inventory available	33.09	5.04	25.26	7.22	126
Inventory outdated	33.40	6.73	24.70	6.89	60
Inventory up-to-date	41.40	7.25	31.60	7.69	69

4.5) Multivariate analysis of literacy and numeracy achievement in the NSES

Two outcome variables are modelled throughout this section: literacy score in 2008 (grade 4) and numeracy score in 2008. Some of the models are simple cross-sectional models without a pre-score while others are so-called value-added models as they include grade 3 achievement on the right-hand side of the equation. The explanatory variables included student characteristics from the student questionnaire of 2008, with imputations from the 2007 student questionnaire in some instances. Similarly, school characteristics were taken mainly from the 2008 principal questionnaire supplemented by some information from the 2007 principal questionnaire. In models predicting literacy achievement, teacher characteristics pertaining to English teachers were obtained from the teacher questionnaire, which was only administered in 2008, while the characteristics of mathematics teachers were used to explain numeracy achievement. Both the principal questionnaire and the teacher questionnaire contained document review features. A description of all explanatory variables that were used in this analysis is presented in Appendix I.

The fact that the same students were tested a year apart is distinctly advantageous for the purposes of multivariate modelling. Omitted variable bias is reduced when modelling achievement in year 2, because factors such as innate ability, student motivation and the prior influence of parents and education should be controlled for in the year 1 score (Rivkin, Hanushek and Kain, 2005). These sorts of value-added models can be estimated using two approaches. Firstly, one can make the dependent variable the gain score from one year to the next. A potential problem with this approach, as Glewwe (2002: 449) points out, is that there may be a lot of noise in the gain score due to measurement error in both years relative to only one year's worth of learning that is signalled by the gain score. This is indeed the case with the NSES data. Attempts to explain the variation in gain scores were not very successful. Therefore, the approach taken was to include the grade 3 score as an explanatory variable predicting the grade 4 score. Although some estimation bias may persist due to measurement error, the inclusion of a pre-score takes the analysis somewhat further than models using simple cross-sectional data, such as those presented in Chapter 3.[55]

[55] Once the third wave of the NSES is ready for analysis, it will be possible to model grade 5 achievement with the grade 4 score as an explanatory variable and to also include the grade 3 score as an instrument to control for measurement error in the grade 4 score. This was the approach adopted by Ladd and Walsh (2002), who examined 5th grade achievement amongst students in North Carolina using 4th grade scores as an explanatory variable and 3rd grade scores as an instrumental variable.

The first models presented in this section are Ordinary Least Squares (OLS) regressions, first for literacy and then for numeracy.[56] In both cases a model excluding the 2007 score is shown as well as a model including the 2007 score. Thereafter, similar models are presented in which the sample was restricted to students in historically black schools. This restriction removes the effect of having two widely different systems in the same sample, with many other student and school characteristics correlated with this divide. These restricted models are better able to address the question of what characteristics predict achievement within the section of the school system that is in most pressing need of improvement. Thereafter, the technique of Hierarchical Linear Modelling (HLM) is applied for the sake of further investigation and testing the consistency of the results. The HLM models are also done first for the full sample of South African schools and then for historically black schools only.

4.5.1) OLS models of literacy and numeracy

4.5.1.1) Models for the full South African sample of schools

Consider Table 4.13, which reports the results of OLS models for literacy achievement in grade 4. The coefficient on "literacy score 2007" in the value-added model is 0.44. The distance away from a value of 1 is a consequence of regression to the mean together with the correlation between 2007 achievement and the other explanatory variables. The inclusion of the pre-score in the value-added model improves the model fit considerably. While the simple cross-sectional model explained about 46% of the variation in grade 4 literacy achievement, the value-added model could explain about 56%.

The set of student characteristics that was associated with literacy and numeracy achievement was remarkably consistent across various model specifications. The number of books at home was only a significant predictor of achievement in several models such as in Column A below. Once the pre-score was included in Column [B], books at home was no longer significantly

[56] In all the OLS regressions in this chapter the method of survey regression was used to account for complex sample design. The stratum variable was province (of which there were 8 due to the non-participation of Gauteng in the NSES), the Primary Sampling Unit (PSU) was the school (of which there were 266) and a person weight for each student, which differed only by province, was specified.

Table 4.13: OLS Regression models for literacy 2008

Explanatory variables	[A]Excluding 2007 score		[B]Including 2007 score	
Student characteristics				
Literacy score 2007			0.44***	(0.02)
Student SES	0.39*	(0.18)	0.23	(0.16)
Male	-2.48***	(0.26)	-1.67***	(0.24)
Young	-0.40	(0.46)	0.12	(0.37)
Old	-2.84***	(0.33)	-2.35***	(0.32)
Household size: large	-1.89***	(0.37)	-1.13***	(0.30)
Read 1 to 3 times a week	1.37**	(0.44)	0.73~	(0.39)
Read more than 3 times	2.39***	(0.62)	1.82***	(0.53)
Books at home: 1 to 10	0.60	(0.39)		
Books at home > 10	1.17*	(0.48)		
Home language English	8.42***	(1.52)	4.74***	(1.15)
Speak English 1-3 times	1.75***	(0.38)	1.70***	(0.33)
Speak English 4+	1.86**	(0.68)	1.54**	(0.51)
English on TV 1-3 times	0.85*	(0.39)	0.70~	(0.37)
English on TV 4+	3.35***	(0.44)	2.67***	(0.43)
School characteristics				
Mean School SES	-9.13***	(1.77)	-4.91**	(1.66)
Mean School SES squared	3.35***	(0.45)	1.85***	(0.38)
Pupil-teacher ratio	-0.18**	(0.07)	-0.06	(0.05)
Teacher absenteeism zero	1.93*	(0.81)		
LTSM Inventory good	1.66*	(0.80)	1.34*	(0.60)
Problems with students index	-0.96*	(0.43)	-0.83**	(0.32)
Curriculum planned using year schedule	1.46~	(0.81)	1.35*	(0.66)
No timetable available			-2.55~	(1.38)
Teacher characteristics				
Full year learning programme	1.55~	(0.87)	1.12~	(0.65)
Short word exercises: average frequency			0.39	(0.83)
Short word exercises: high frequency			1.66~	(0.97)
Constant	29.69***	(3.45)	19.16***	(2.67)
R-squared statistic	0.4591		0.5607	
N	10 860		10 860	

Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

The regressions included dummy variables for the provinces but the coefficients on these are not reported in the table. Also, dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, teacher absenteeism, whether the teacher has a learning programme for the full year and the frequency of short word exercises. Table A.15 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

associated with literacy achievement. However, student SES, age, household size, frequency of reading on one's own at home, home language and exposure to English were consistently important student characteristics to include in the models.

It is interesting to note which aspects of home background were not associated with achievement under the models in this section. Family structure, as measured by the number of parents present at home, was not significantly associated with achievement in any of the models that were estimated. This does not necessarily mean that it does not matter, as the effect of family structure may be contained within the effect of student SES. Another variable that one might have expected to influence achievement was the availability of help with homework from an adult at home. However, this variable also was not significantly associated with achievement in the multivariate analysis. Similarly, there was no significant effect of reading with an adult at home. Yet, children who reported reading on their own at home performed better than those who did not, conditional upon all the other characteristics. As Table 4.13 shows, this positive effect was greater for those who read at least four times a week than for those who read between 1 and 3 times a week.

The effects of student characteristics were generally somewhat smaller in the value-added models due to the fact that much of the prior influence of these factors should already be contained within the pre-score. The effect of student SES on literacy achievement was in fact not significantly different from zero in the value-added model, as Table 4.13 shows. This may mean that the effect of SES is already evident in grade 3 achievement and no further effect on grade 4 achievement is observable. However, to a large extent SES determines the quality and level of affluence of the schools children attend. The mean SES within each school was strongly associated with grade 4 literacy, even in the value-added model. The most important influence of student SES may therefore be through selection into schools of differential combined SES (and associated quality).

Male students performed worse than females and this effect was consistent in all the models, including the value-added models. Students who were older than the norm (10 years old) also performed worse in all the models. Students whose home language was English had a performance advantage over other students that remained evident in the value-added models. This is understandable given that the tests were in English. A consistent pattern that emerged was that greater exposure to English through speaking and hearing English on the television was associated with higher achievement even after controlling for home language.[57] Apart from the obvious language proficiency effect, the possibility exists that this result may be picking up a further effect of SES – those who have televisions at home and frequently speak English outside school may also be more affluent.

The coefficients on the mean of school SES and the square thereof were statistically significant in both column [A] and [B]. The positive coefficient on the squared term indicates that the effects of school SES on both achievement and learning are most pronounced at higher levels of school SES. This non-linear and convex relationship between school SES and educational achievement in South Africa was described extensively in Chapter 3 of this thesis.

The pupil-teacher ratio was included in all the models even when it did not appear to exert a significant effect, as it is generally standard practice to include a measure of pupil-teacher ratio or class size in education production function analysis. As in Table 4.13, the pupil-teacher ratio generally yielded a fairly small and sometimes statistically insignificant effect on achievement. However, as discussed in Chapter 3, a more important factor than the ratio of students to teachers in a school is the actual number of students in a class at any point in time. Unfortunately the NSES did not capture class size in this way. Therefore, the weak influence of the pupil-teacher ratio in this analysis should not be regarded as evidence that class size is unimportant.

The main focus of this chapter is on the identification of indicators of school and teacher quality. In Column 1 of Table 4.13 a positive effect was obtained for schools in which no teachers were absent on the day of the survey. Although this once-off measurement may not accurately reflect teacher absenteeism over a longer period, it avoids the response bias and subjectivity often present when school principals are asked about the severity of teacher absenteeism. Moreover, the fact that this variable is significantly associated with achievement in many of the models estimated in this section indicates that it is probably capturing teacher absenteeism, and perhaps

[57] One might expect an interaction between home language and exposure to English to demonstrate greater gains from exposure to English for non-English speakers. However, an estimation of this interaction (not reported here) suggested the opposite. This result was essentially meaningless as it was driven by poor performance amongst the very small number of English speakers who reported little exposure to English through speaking and through television.

even school organisation and professional work ethic more generally, although with a certain degree of measurement error.

The coefficient on the dummy variable for schools having an inventory for Learning and Teaching Support Materials (LTSM) that is present and up-to-date was positive and significant in both models in Table 4.13. This is a good indicator of how well resources are managed and used by schools. An index derived from a number of questions about problems with student behaviour was negatively associated with literacy achievement. However, this variable was not consistently associated with achievement in most of the other models reported in this section. A positive effect was obtained for schools in which curriculum planning was reportedly done using a year schedule. School principals were given a list of ways in which curriculum planning could be undertaken and asked to identify which of those were practised in their schools. The options were not mutually exclusive. The result here may suggest that this variable is an indicator of the level and type of planning and organisation that distinguishes more effective schools from less effective ones. In 15 schools no timetable was available for the fieldworker to observe. A school timetable is supposed to be a crucial and ever-present feature in the daily running of a school. It is therefore reasonable to regard not having an easily accessible timetable as a flag for a dysfunctional school.

As Table 4.13 shows, only two variables from the teacher instrument were associated with literacy achievement in the OLS models. In both columns [A] and [B] a positive and significant coefficient was obtained for the dummy variable indicating that a full-year learning programme was seen by the fieldworker. It would be unwise to conclude from this result that student achievement will improve by the size of the coefficient if teachers planned the learning programme for the full year. Rather, this variable should be regarded as a proxy for teacher organisation and preparation in general. In the value-added model there was some evidence that a high number of short word exercises in student workbooks was associated with better achievement, although this was only significant at the 10% level of confidence. It is noteworthy that many other teacher characteristics did not warrant inclusion in the models for literacy achievement. In particular, teacher knowledge as measured by the short comprehension test was not significantly associated with student achievement after controlling for all the other variables in the models. This may be simply a consequence of the short test not adequately differentiating between teachers with varying degrees of subject knowledge.

An alternative way of presenting the results of the models shown in Table 4.13 is to consider what effects various improvements in school and teacher characteristics could have on the national average of literacy achievement. The mean literacy score in 2008 for the sample of students that was included in the OLS literacy models was 26.57%. Table 4.14 shows the predicted changes to this sample mean associated with changing the entire sample of schools to have the positive value of the school and teacher characteristics included in the OLS literacy models. The largest effect on the sample mean was predicted for changing schools in which some teachers were absent (on the day of the survey) to having no teachers absent. Of course, it is unrealistic always to maintain zero absenteeism. This calculation should rather be interpreted as the predicted change in the national average associated with improving teacher attendance in general (and improving whatever else for which this variable is acting as a proxy) in the "some teachers absent" group of schools to the level at which it is in the "zero teacher absenteeism" group. The combined effect of improving characteristics would be to raise the mean sample average by 3.29 percentage points under the model excluding the 2007 score, and by 2.71 percentage points under the parameters of the value-added model. The combined effect of these characteristics is the more relevant figure as none of the individual characteristics should be conceived of as inputs that will yield the exact outcomes predicted by the models, but rather as indicators of the underlying concepts of school and teacher effectiveness.

Table 4.14: Estimated effects of change in characteristics on the literacy national average

(Original sample mean = 26.57%)

	Model excluding 2007 score		**Model including 2007 score**	
	Predicted new mean	Gain	Predicted new mean	Gain
Teacher absenteeism zero	27.84	1.27	-	-
LTSM Inventory good	27.36	0.79	27.21	0.64
Curriculum planned using year schedule	27.18	0.61	27.13	0.57
No timetable available	-	-	26.69	0.13
Full year learning programme	27.18	0.61	27.01	0.44
Short word exercises	-	-	27.50	0.93
Combined effect of improved characteristics	29.85	3.29	29.28	2.71

The numeracy models are presented in Table 4.15 below. As was the case for literacy, the value-added model accounted for approximately 56% of the variation in numeracy achievement.

Table 4.15: OLS Regression models for numeracy 2008

Explanatory variables	**[1]Excluding 2007 score**		**[2]Including 2007 score**	
Student characteristics				
Numeracy score 2007			0.48***	(0.02)
Student SES	0.26	(0.27)	-0.06	(0.21)
Male	-1.13**	(0.35)	-0.61*	(0.30)
Young	-0.07	(0.72)	0.22	(0.52)
Old	-3.99***	(0.53)	-2.88***	(0.47)
Household size: large	-2.37***	(0.54)	-1.86***	(0.42)
Read 1 to 3 times a week	3.49***	(0.67)	1.72***	(0.51)
Read more than 3 times	4.97***	(1.07)	3.36**	(1.21)
Home language English	9.87***	(2.01)	6.82***	(1.57)
Speak English 1-3 times	2.43***	(0.65)	1.81**	(0.59)
Speak English 4+	2.01~	(1.05)	1.72*	(0.86)
English on TV 1-3 times	0.66	(0.66)	0.01	(0.56)
English on TV 4+	4.50***	(0.69)	2.63***	(0.54)
School characteristics				
Mean School SES	-16.89***	(3.38)	3.05***	(0.82)
Mean School SES squared	4.88***	(0.78)		
Pupil-teacher ratio	-0.38***	(0.11)	-0.28**	(0.09)
Media and Communication facilities index	2.45*	(1.02)		
Assessment record keeping good	0.25	(1.88)		
Assessment record keeping poor	-2.79	(2.16)		
Assessment record keeping very poor	-4.87*	(2.41)		
No timetable available	-4.87*	(2.43)	-4.52**	(1.62)
Teacher absenteeism zero	2.74*	(1.38)	2.24*	(1.13)
Curriculum planned using year schedule			1.70	(1.07)
Teacher characteristics				
Maths teacher test score: 100%	2.99~	(1.77)	2.93~	(1.67)
Maths topics covered: 25 plus	4.69**	(1.54)	2.28*	(1.14)
Time spent on assessment: low			4.60**	(1.58)
Time spent on assessment: high			4.65**	(1.77)
Time spent on assessment: vhigh			2.44	(1.50)
Constant	50.05***	(5.08)	20.53***	(3.59)
R-squared statistic	0.4223		0.5646	
N	11383		11813	

Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

The regressions included dummy variables for the provinces but the coefficients on these are not reported in the table. Also, dummy variables controlling for non-response were included for the following characteristics: Household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, teacher absenteeism, teacher mathematics test result, time spent on assessment and the number of mathematics topics covered. Table A.16 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

The estimated effects of student characteristics were very similar to those in the literacy models, although the number of books at home was not associated with numeracy achievement in either model. Otherwise, conditional upon all other factors in the models, those who reported having more than two siblings did worse than those in smaller households; those who read frequently at home on their own did better; and those who were exposed to English more often also did better. The coefficient on student SES was not significantly different from zero in both numeracy models. As it has been shown that the unconditional association between SES and achievement is very strong, this result would suggest that the effect of SES is largely bound up with the mean SES of schools to which children gain access and that little further effect of SES exists.

A noteworthy school-level variable that did not emerge as significant in the numeracy models was the availability of sufficient grade 4 mathematics textbooks. However, a composite index for the availability and quality of various media and communication facilities, such as projectors and copying facilities, was significantly associated with numeracy achievement in Column [1]. The evidence for this effect was mixed and was sensitive to model specification, as forthcoming models will indicate.

A general observation pertaining to Table 4.15 as well as the rest of the models in this section is that school resource variables were less consistently and importantly related to achievement than were variables that can be thought of as indicators of effective school management. The dummy variables for both the lack of an available timetable and teacher absenteeism came through very strongly in the models in Table 4.15. Although the LTSM inventory dummy did not warrant inclusion in these models, another indicator of school organisation did emerge as significant: the quality of assessment records. Students in schools where the quality of assessment records was very poor did worse than those in schools where these were both present and up-to-date.

A variable from the teacher questionnaire which also pertains to assessment was the time per week spent by the mathematics teacher on assessment and marking. In the value-added model, students taught by teachers who reported spending less than 1 hour a week on assessment performed worse in numeracy than those whose teachers reported spending between 1 and 5 hours a week on assessment. However, the performance of those whose teachers reported spending more than 5 hours a week on assessment was not significantly different from those whose teachers spent less than 1 hour. Taking this finding together with that regarding the quality of assessment records, it appears that regular and well-managed assessment is beneficial to numeracy achievement, or at least that good assessment practice is a signal of an effective school. However, self-reporting by teachers casts some doubt on the accuracy of this variable.

In contrast to the literacy models, a significant effect of teacher knowledge was obtained in both models in Table 4.15. A student achievement advantage of slightly less than 3% was associated with a score on the teacher mathematics test of 100%. This advantage remained even once grade 3 achievement was accounted for in the value-added model. No significant differences in achievement were associated with variations in teacher knowledge below 100%. Sound teacher knowledge therefore seems necessary before any noticeable impact on student achievement accrues. There was also a reasonably large, positive and significant effect associated with having covered more than 25 curriculum topics, as identified in student workbooks. This variable was fairly consistently associated with numeracy achievement across the models presented in this chapter. The number of topics can therefore be considered a good indicator of curriculum coverage and, more fundamentally, of the amount of work that is being undertaken in classes. This aspect of classroom practice clearly has an important impact on student achievement.

The predicted effects of improvements in the school and teacher characteristics on the national average were greater for numeracy than for literacy. As Table 4.16 shows, the national average could be expected to improve most substantially in response to raising teacher knowledge and curriculum coverage across the system. The combined effect of a universal attainment of positive values on the indicators of school and teacher quality in the model excluding the pre-score would be to raise the national average from 34.21% to 42.29%. A smaller but still considerable gain of 6.47% is predicted under the value-added model.

To summarise, the numeracy models provide evidence that good assessment practices, teacher commitment and planning, teacher knowledge and curriculum coverage vary substantially across South African schools and are strongly linked to educational achievement.

Table 4.16: Estimated effects of change in characteristics on the numeracy national average

(Original sample mean = 34.21%)

	Model excluding 2007 score		**Model including 2007 score**	
	Predicted new mean	Gain	Predicted new mean	Gain
Assessment record keeping	35.08	0.87		
No timetable available	34.45	0.24	34.43	0.23
Teacher absenteeism zero	36.01	1.80	35.68	1.47
Curriculum planned using year schedule			34.92	0.71
Maths teacher test score: 100%	36.38	2.17	36.34	2.13
Maths topics covered: 25 plus	37.20	3.00	35.66	1.46
Time spent on assessment			34.68	0.47
Combined effect of improved characteristics	42.29	8.08	40.68	6.47

4.5.1.2) OLS Models for historically black schools only

With two very differently-performing sections existing within the South African school system, the incentive to migrate to the better functioning schools is obvious. Similarly, educational interventions based on providing scholarships for disadvantaged children to attend elite schools are effective for the individuals that benefit, but do not offer a system-level solution. The more pressing policy question is to identify factors that are likely to affect outcomes within historically disadvantaged schools. Moreover, there are technical reasons to analyse achievement within the historically black sample separately. Gustafsson (2007: 94) has warned that factors that may affect outcomes in one section of schools can be glossed over in a single model for South Africa at large. Van der Berg (2008), too, has observed that separate data-generating processes necessitate separate modelling. So many factors at the community, family and school levels that all have far-reaching effects on education are distributed along the same divide as that splitting the historically different parts of the school system. In order to take out this duality, therefore, separate models for historically black schools were estimated and are reported in this section.

The results of the OLS models for literacy are presented in Table 4.17. The sample size remained sufficiently large as about 80% of schools in the NSES were historically black schools, a proportion that is roughly representative of the broader population of schools. As was the case in the analysis of the PIRLS data for South Africa in the previous chapter, the models for

Table 4.17: OLS Regression models for literacy in historically black schools

Explanatory variables	[1]Excluding 2007 score		[2]Including 2007 score	
Student characteristics				
Literacy score 2007			0.44***	(0.03)
Student SES	0.28	(0.17)	0.08	(0.15)
Male	-2.30***	(0.25)	-1.68***	(0.24)
Young	-0.49	(0.47)	0.04	(0.35)
Old	-2.73***	(0.33)	-2.36***	(0.29)
Household size: large	-1.11**	(0.41)	-0.79*	(0.33)
Read 1 to 3 times a week	1.21**	(0.46)	0.64	(0.43)
Read more than 3 times	1.96**	(0.64)	1.54**	(0.56)
Books at home: 1 to 10			0.70*	(0.33)
Books at home > 10			0.47	(0.41)
Speak English 1-3 times	1.95***	(0.44)	1.69***	(0.35)
Speak English 4+	1.55~	(0.89)	1.40*	(0.63)
English on TV 1-3 times	0.92*	(0.39)	0.68*	(0.34)
English on TV 4+	3.04***	(0.42)	2.17***	(0.35)
School characteristics				
Mean School SES	-5.11*	(2.50)	-3.92*	(1.86)
Mean School SES squared	2.09**	(0.77)	1.55**	(0.54)
Pupil-teacher ratio	-0.01	(0.07)	-0.03	(0.05)
Students per grade 4 classroom	-0.04*	(0.02)		
Teacher absenteeism zero	2.10**	(0.79)	1.98**	(0.63)
No timetable available	-3.04*	(1.51)		
Teacher characteristics				
Full year learning programme			1.24*	(0.63)
Time spent on assessment: low	1.15	(1.11)	0.46	(0.93)
Time spent on assessment: high	3.59**	(1.32)	1.88*	(0.95)
Time spent on assessment: vhigh	0.08	(1.26)	-0.71	(0.96)
Constant	27.77***	(3.80)	14.87***	(2.56)
R-squared statistic	0.1869		0.3146	
N	8868		9232	

Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

The regressions included dummy variables for the provinces but the coefficients on these are not reported in the table. Also, dummy variables controlling for non-response were included for the following characteristics: Household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, teacher absenteeism, whether the teacher has a learning programme for the full year and the time spent on assessment. Table A.17 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

historically black schools were able to explain less of the variation in achievement than the full sample models. This is partly due to the removal of the key distinction between the historically different parts of the system, which accounts for a great deal of overall variation, and partly a reflection of the difficulty in explaining achievement differences within this group of schools. The value-added model is able to explain only about 31% of the variation in literacy achievement.

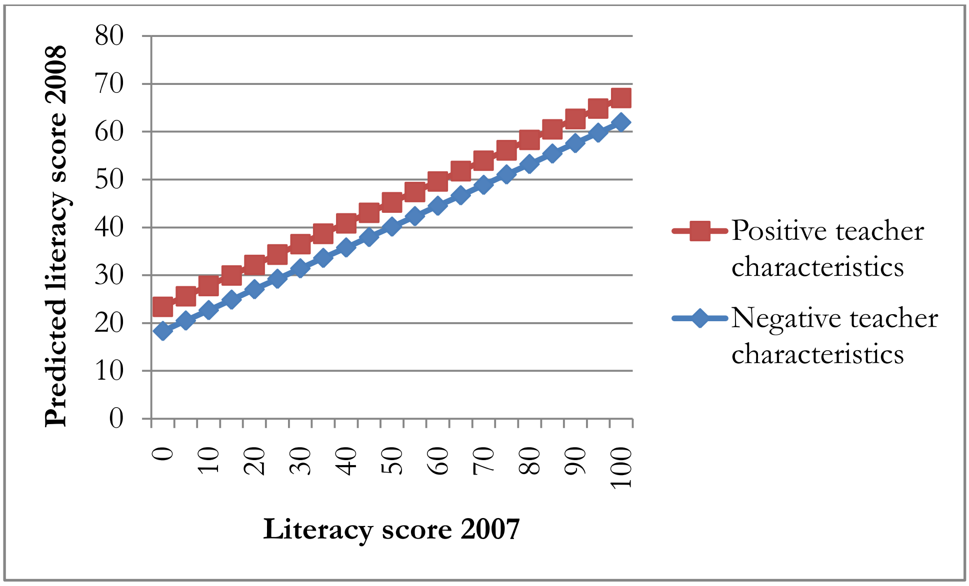
The estimated effects of student characteristics were broadly similar to those obtained in the full models. It is significant that exposure to English through speaking and television was still associated with better achievement amongst this group of students, the vast majority of whom were not mother-tongue English speakers. It is interesting, too, that in these models student SES was not significantly associated with achievement although the mean of SES in the school they attended did have an important effect.

The pupil-teacher ratio did not significantly predict achievement, although a significant effect was obtained for the ratio of grade 4 students to classrooms. This effect, however, was not consistently found across the models and was too small to justify bold conclusions.

Several of the school and teacher variables that were significant in the literacy model for the full South African sample were not significant in the restricted models in Table 4.17. These included the state of LTSM inventories, the dummy for whether curriculum planning was done on the basis of a year schedule and the frequency of short word exercises. This could indicate that these factors accounted for performance differences between the historically black schools and the rest of the system, in a sense acting as proxy for former department. The most important result amongst the school and teacher characteristics in the literacy models for historically black schools is the achievement advantage associated with a school's having no teachers absent on the day of the survey. In both columns [1] and [2] an achievement advantage of about 2% was estimated. Although only a once-off sample of teacher absenteeism, the "hardness" of this variable is evidently affording it predictive power. Moreover, it is probably acting as a proxy for more fundamental issues of management efficiency and teacher work ethic.

Figure 4.18 presents the results of the value-added model for literacy in historically black schools graphically. The top line shows predicted grade 4 literacy achievement, at given levels of grade 3 achievement and holding all other factors constant, for being in a school where teacher absenteeism was zero on the day of the visit, and in a class where the teacher had a learning programme planned for the full year and where the teacher spent between 3 and 5 hours a week on assessment as opposed to less than 1 hour. The bottom line is the predicted achievement for students with the reverse of the aforementioned characteristics.[58] As the figure demonstrates, the combined effect of these characteristics on grade 4 achievement is just above 5 percentage points for students with the same achievement in grade 3. It is thus clear that teacher attendance, planning and assessment practice do have an important impact on student achievement within the historically black section of the school system.

Figure 4.18: The effect of several teacher characteristics under the value-added model for literacy in historically black schools



The OLS numeracy models for historically black schools are presented in Table 4.18. The overall model fit was slightly better than it was for the literacy models although considerably less variation could be explained than when modelling numeracy for the full South African sample. As before, a similar set of student characteristics provided significant predictors. SES at the individual level was, again, not statistically significant, although this time the mean school SES was also not significant in the value-added model. This may imply that SES (at the individual

[58] The figure applies to a student of mean SES within the restricted sample in a school of mean school SES and mean pupil-teacher ratio, who reads a lot, has more than 10 books at home, is frequently exposed to English through speaking and on television and with all the other dummy variables taking the value of the reference categories.

Table 4.18: OLS Regression models for numeracy in historically black schools

Explanatory variables	[1]Excluding 2007 score		[2]Including 2007 score	
Student characteristics				
Numeracy score 2007			0.47***	(0.03)
Student SES	0.13	(0.28)	-0.01	(0.22)
Male	-1.07**	(0.37)	-0.77*	(0.33)
Young	-0.36	(0.80)	0.01	(0.55)
Old	-3.64***	(0.51)	-2.45***	(0.49)
Household size: large	-1.05	(0.63)	-1.12*	(0.50)
Read 1 to 3 times a week	3.21***	(0.73)	1.60**	(0.61)
Read more than 3 times	4.32***	(1.25)	3.06*	(1.38)
Speak English 1-3 times	2.19**	(0.69)	1.84**	(0.63)
Speak English 4+	0.69	(1.35)	0.95	(1.16)
English on TV 1-3 times	0.54	(0.68)	0.47	(0.58)
English on TV 4+	3.77***	(0.70)	2.65***	(0.54)
School characteristics				
Mean School SES	-8.91~	(4.65)	1.44	(1.14)
Mean School SES squared	2.46~	(1.26)		
Pupil-teacher ratio	-0.16	(0.12)	-0.13	(0.11)
Media and Communication facilities index	2.17*	(0.98)		
Assessment record keeping good	0.34	(2.35)		
Assessment record keeping poor	-2.29	(2.45)		
Assessment record keeping very poor	-4.88*	(2.46)		
Teacher absenteeism zero	3.03~	(1.61)	3.10*	(1.32)
Teacher characteristics				
Maths topics covered: 25 plus	5.81***	(1.62)	2.69~	(1.37)
Time spent on assessment: low			3.02~	(1.64)
Time spent on assessment: high			4.38*	(1.96)
Time spent on assessment: vhigh			0.38	(1.61)
Constant	35.10***	(6.22)	12.19**	(3.91)
R-squared statistic	0.1691		0.3685	
N	8838		9232	

Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

The regressions included dummy variables for the provinces but the coefficients on these are not reported in the table. Also, dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, teacher absenteeism, the number of mathematics topics covered and the time spent on assessment. Table A.18 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

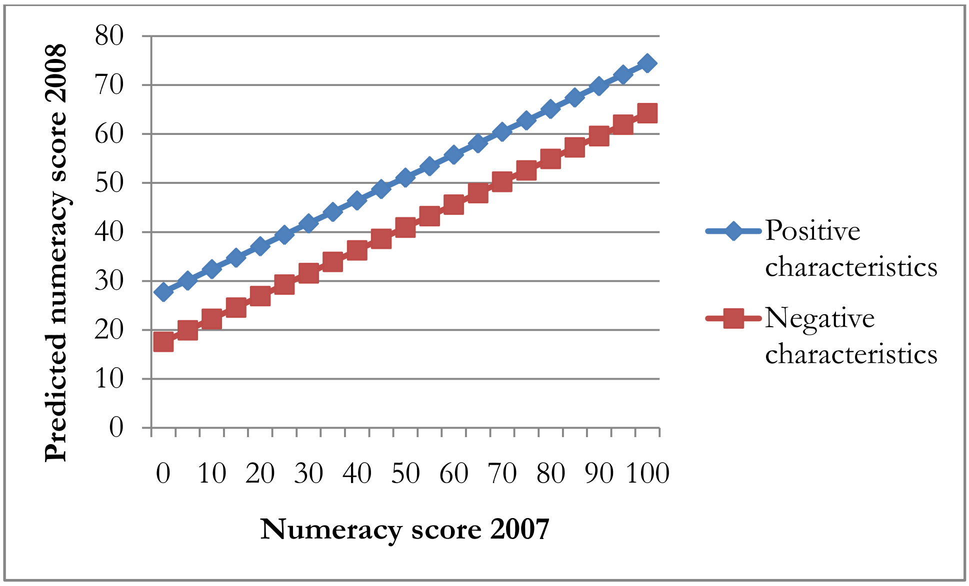
and school level) has largely already taken effect by grade 3 and is reflected in the grade 3 numeracy score. This result is also partly attributable to the fact that there is less variation in mean school SES *within* the historically black group of schools than *between* this group and historically privileged schools.

As was the case for the full sample numeracy models, a one standard deviation increase in the index for media and communication facilities was associated with an improvement in the predicted numeracy score of just over 2%. The achievement advantage associated with zero teacher absenteeism was particularly large in this case: just over 3% in both columns [1] and [2]. There was again some evidence that the quality of assessment records and the time spent on assessment by teachers was significantly associated with numeracy achievement.

The effect of curriculum coverage as measured by the number of mathematics topics covered was large and significant. In the model excluding the grade 3 score, students in classes where more than 25 topics were evident in student workbooks enjoyed an advantage of 5.81 percentage points. Teacher knowledge did not warrant inclusion in this model, although some evidence of a significant effect was found when estimating an HLM for numeracy in historically black schools, as will be shown in Section 4.5.2.2. It follows, therefore, that no strong conclusions should be made about this result.

Figure 4.19 graphically depicts the difference in predicted numeracy achievement attributable to curriculum coverage, time spent on assessment and teacher absenteeism according to the parameters of the value-added model in Table 4.18. For given levels of grade 3 numeracy, students who were in a school where teacher absenteeism was zero, and in a class where more than 25 mathematics topics were covered and the teacher spent between 3 and 5 hours a week (as opposed to less than 1 hour) on assessment did approximately 10 percentage points better than those with the opposite characteristics. This constitutes further evidence that teacher attendance and work ethic, assessment practices and curriculum coverage do impact in significant ways on student achievement within the historically disadvantaged section of schools.

Figure 4.19: The effect of several teacher characteristics under the value-added model for numeracy in historically black schools



4.5.2) HLM models of literacy and numeracy

In order to test the sensitivity of the results discussed in the previous section to the model specification, several hierarchical linear models (HLM) of literacy and numeracy in the NSES were estimated.[59] As in the previous section, this was done first for the full South African sample of schools and then for historically black schools only.

4.5.2.1) Models for the full South African sample of schools

The fully unconditional HLM model can be used to calculate intra-class correlation coefficients or *rho* values. As explained in Chapter 3, the *rho* value describes how much of the variation in achievement is attributable to differences between students within schools and how much is attributable to differences between schools. The *rho* values for literacy and numeracy for each

[59] The HLM methodology was explained in Chapter 3.

year of the NSES are reported in Table 4.19.[60] The *rho* values ranged from 0.53 to 0.60, which is quite high but somewhat lower than other estimates of South African intra-class correlation coefficients. In the PIRLS data, South Africa had the highest *rho* value of all the participants at 0.67, indicating that 67% of the total variation in South African reading achievement was attributable to between-school variation. One possible reason for the slightly lower *rho* values obtained from the NSES data is the omission of the Gauteng province from the survey. This province is known to have a sizeable contingent of top-performing schools whose inclusion would probably have served to raise between-school variation.[61]

Table 4.19: Rho values in the NSES

	rho value
Literacy 2007	0.57
Literacy 2008	0.53
Numeracy 2007	0.60
Numeracy 2008	0.54

HLM is a form of multi-level modelling, with regressions being carried out at more than one level of analysis, as was explained more extensively in Chapter 3. In this case, the first level models the effect of student characteristics on achievement and does so separately within each school. The level 2 (or between-school) model aims to explain variation in the average achievement of schools based on school and teacher characteristics.[62] This is sometimes called "modelling the intercept". At the second level it is also possible to investigate how relationships between student characteristics and achievement differ based on school characteristics. For example, the impact of student SES on achievement may be substantially different across schools, and specific classroom factors may underlie these differences.

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[60] In the fully unconditional models as in all the HLM models in this chapter, the student level weight was given by the sampling weight, which differed only by province, and the school level weight was given by the sum of the student weights within each school.

[61] The *rho* value for South Africa based on the PIRLS data was 0.67. This decreased only somewhat to 0.65 when Gauteng was omitted from the calculation, indicating that the absence of Gauteng in the NSES probably does not completely account for the lower than normal *rho* values obtained.

[62] The units of analysis in the level 2 models were actually classes rather than schools as some schools had more than one class that participated in the survey. However, the level 2 model will be referred to as the "between-school" model as there were only a small number of schools that have more than one class.

An HLM model for literacy achievement excluding the grade 3 score is presented in Table 4.20. The level 1 (within-school) model produced very similar results to those of the OLS models. Negative effects were associated with being male, older than the norm and coming from a large household. Reading at home on one's own and frequent exposure to English were positively associated with literacy achievement. The effect of student SES was fairly small on average – a one standard deviation increase in SES was associated with an increase in literacy achievement of 0.62 percentage points – although this relationship differed significantly between schools. Figure 4.20 presents a random sample of within-school SES slopes, and shows that in some schools the relationship was fairly steep while in others it was effectively flat.

It was decided to specify a level 2 model for the SES slope because of this variation between schools. Three school characteristics were found that were significantly associated with the SES slope. In schools where the mean SES was high, the slope between student SES and literacy achievement was steeper. The slope was also steeper in classes taught by a teacher who scored 6 or 7 out of 7 in the comprehension test. Moreover, in classes where long sentence exercises were frequently carried out, the SES slope was steeper. This indicates that high SES students benefit more from being in affluent schools, from exposure to knowledgeable teachers and from having more frequent exercises than do poor students. This interaction between school mean SES, teacher knowledge and the SES slope is presented graphically in Figure 4.21. The graph shows that the line height is strongly influenced by school mean SES while the slope is strongly linked to teacher knowledge. This finding is in line with the results of the HLM models based on PIRLS presented in the previous chapter, which showed that more affluent students stood to gain more from educationally advantageous school characteristics. Specifically, smaller classes and teacher qualifications influenced the SES slope.

Table 4.20: HLM model for Literacy in grade 4 (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	27.27***
School mean SES	4.51***
Pupil-teacher ratio	-0.43*
Media and Communication facilities index	1.54**
Full set of class texts present	2.35*
Curriculum planned using year schedule	2.17*
LTSM Inventory good	3.42***
No timetable available	-6.76**
English teacher test score: 1 or 2	-3.03
English teacher test score: 3	-3.98*
English teacher test score: 4 or 5	-0.85
The student SES achievement slope, β_1	
Intercept	0.62***
School mean SES	0.73**
English teacher test score: 6 or 7	1.26**
Long sentence exercises: 1 to 4 times	0.13
Long sentence exercises: more than 4 times	1.96*
Male	-2.25***
Young	0.50~
Old	-3.06***
Household size: large	-0.99***
Read 1 to 3 times a week	0.82~
Read more than 3 times	1.66**
Speak English 1-3 times	1.58***
Speak English 4+	1.39*
English on TV 1-3 times	0.65*
English on TV 4+	3.13***

Random effects	**Variance Components**
Intercept, $\mu 0j$	50.12***
Student SES slope, $\mu 1j$	1.08
Level-1 error, rij (σ^2)	95.01

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table Notes:

Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, whether curriculum planning happened using a year schedule, English teacher test scores and the frequency of long sentence exercises. Table A.19 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.53
Proportion of within-school variance explained by the model = 0.08
Proportion of between-school variance in the average achievement (**β_0**) explained by the model = 0.57
Proportion of between-school variance in the SES slope (**β_1**) explained by the model = 0.52

Figure 4.20: Random sample of within-school SES slopes

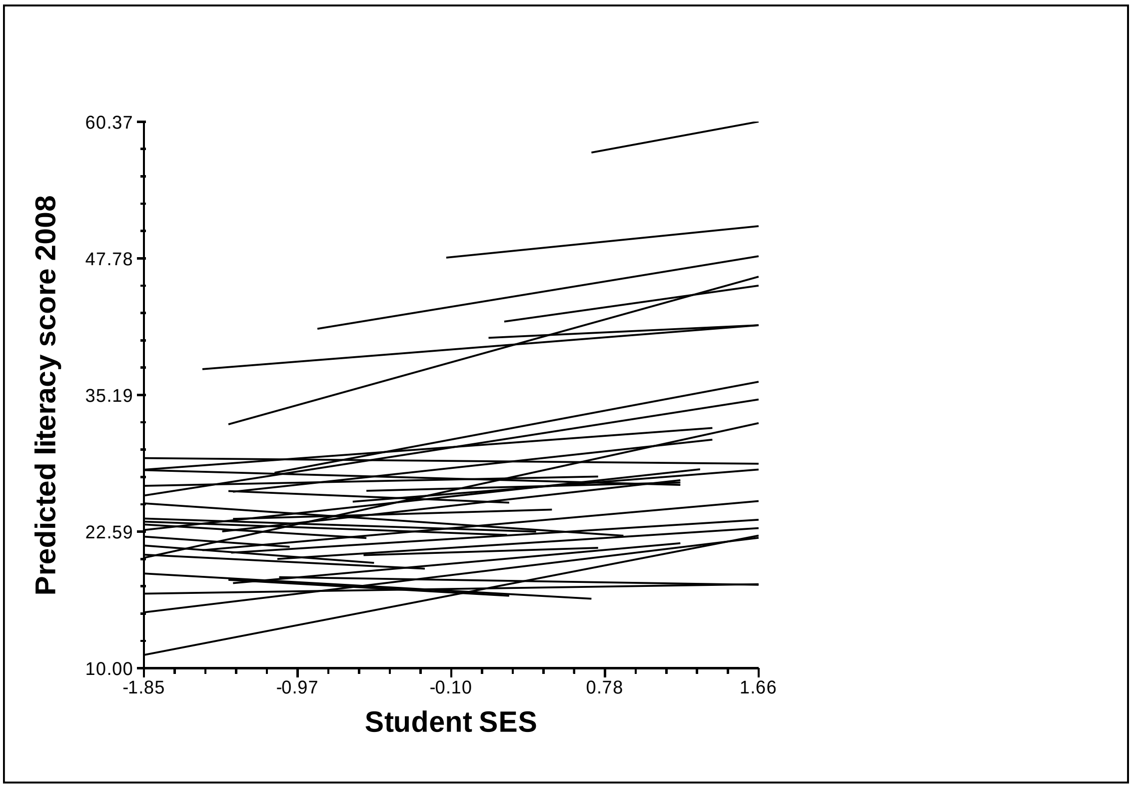
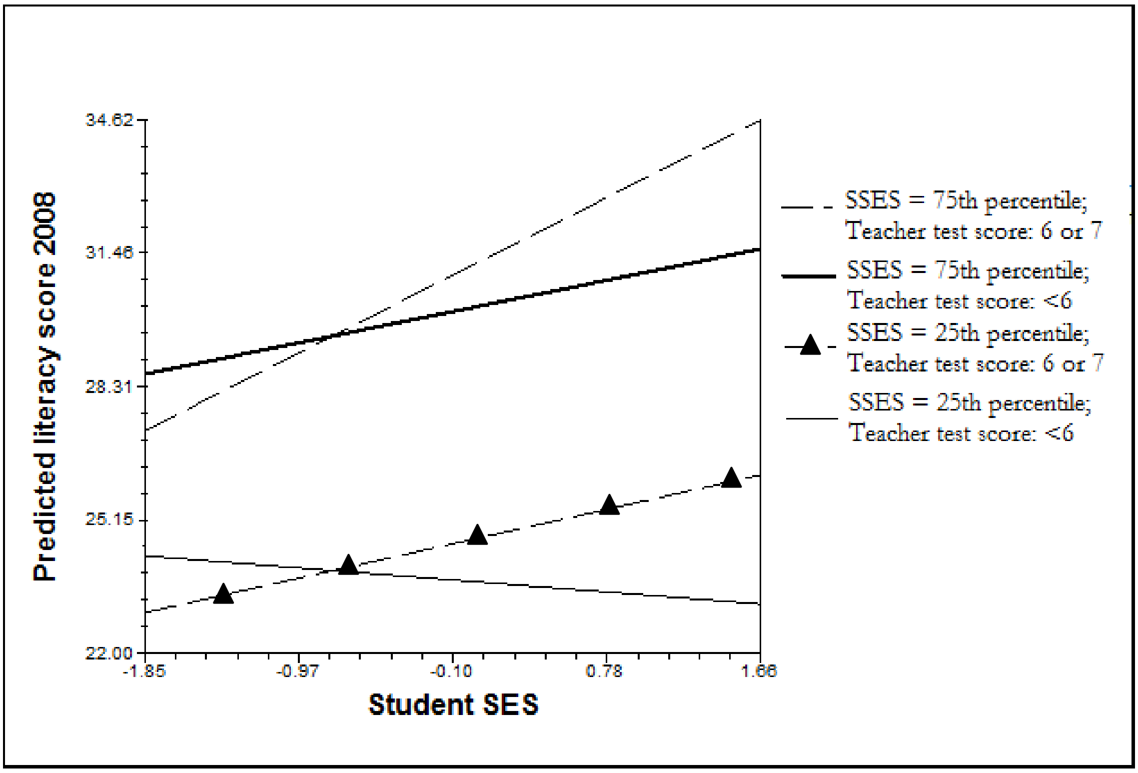


Figure 4.21: SES slopes by school mean SES and teacher knowledge



Turning to the between-school model in Table 4.20, three measures of school resources were found to be significantly associated with the average literacy achievement in schools. These were the pupil-teacher ratio, the index for media and communication facilities and a dummy variable indicating that at least one full set of class texts was available to that grade 4 class. Somewhat larger effects were obtained for three indicators of school organisation – the dummy variable for whether curriculum planning was done using a year schedule, the state of LTSM inventories and the availability of a timetable. Weak evidence was found that low scores on the teacher comprehension test were associated with lower student achievement, although only the dummy for a score of 3 out of 7 was statistically significantly different from the effect of a score of 6 or 7.

The results were broadly similar for the value-added HLM model for literacy, reported in Table 4.21. The inclusion of grade 3 literacy achievement as an explanatory variable improved the model fit considerably. The proportion of the within-school variance explained by the model was 0.19 as opposed to just 0.08 in the model without a pre-score. Similarly, the proportion of the between-school variance explained by the model increased from 0.57 to 0.77.

The same set of student characteristics justified inclusion in the level 1 model, although the SES slope was not significantly different from zero and did not vary enough between schools to justify modelling the slope. In general, the estimated effects on student characteristics were slightly smaller in the value-added model as much of their prior impact would have been contained within the grade 3 score.

The most dominant determinant of the average achievement of schools remains their mean SES. The estimated effect of this variable is depicted in Figure 4.22. The figure demonstrates that the predicted literacy achievement in grade 4 is about 5 percentage points higher for students in schools at the 75th percentile of school SES than students with the same grade 3 score who are in schools at the 25th percentile.

Table 4.21: HLM model for Literacy in grade 4 (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	27.00***
School mean SES	2.63***
Pupil-teacher ratio	-0.23*
Media and Communication facilities index	0.85~
Curriculum planned using year schedule	2.07**
LTSM Inventory good	2.56***
No timetable available	-4.91**
English teacher test score: 1 or 2	-1.40
English teacher test score: 3	-2.55*
English teacher test score: 4 or 5	-0.81
Literacy score 2007 (grade 3)	0.41***
Student SES	0.27
Male	-1.57***
Young	0.61*
Old	-2.75***
Household size: large	-0.86**
Read 1 to 3 times a week	0.46
Read more than 3 times	1.19*
Speak English 1-3 times	1.42***
Speak English 4+	1.39*
English on TV 1-3 times	0.34
English on TV 4+	2.32***

Random effects	**Variance Components**
Intercept, μ0j	26.94***
Level-1 error, rij (σ^2)	83.95

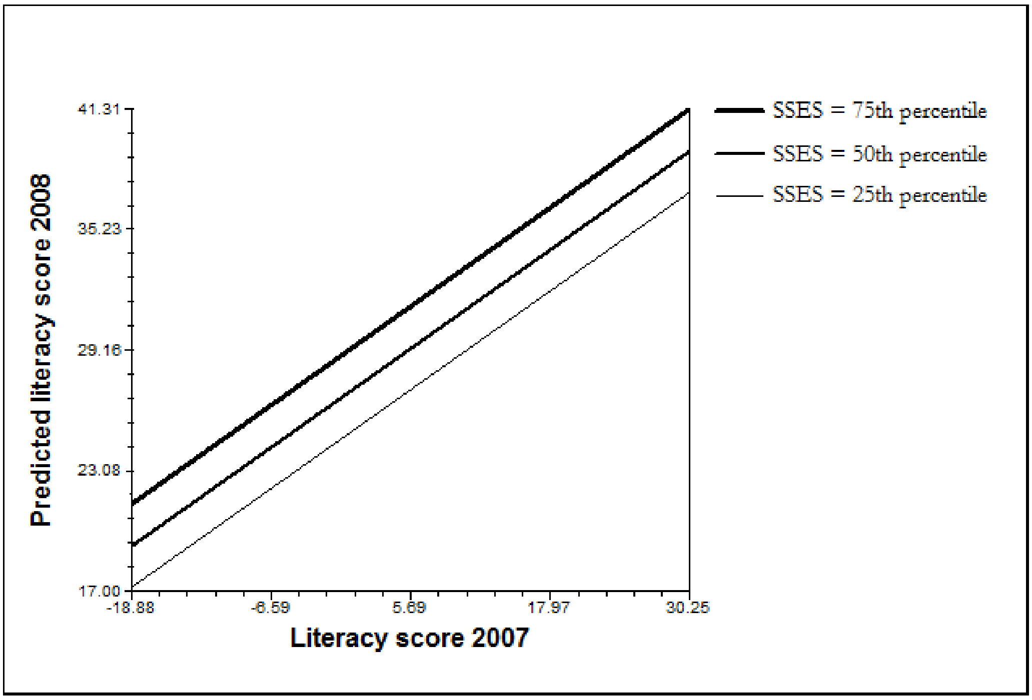
~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table Notes:

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, whether curriculum planning happened using a year schedule and English teacher test scores. Table A.20 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.53
Proportion of within-school variance explained by the model = 0.19
Proportion of between-school variance in average achievement (β_0) explained by the model = 0.77

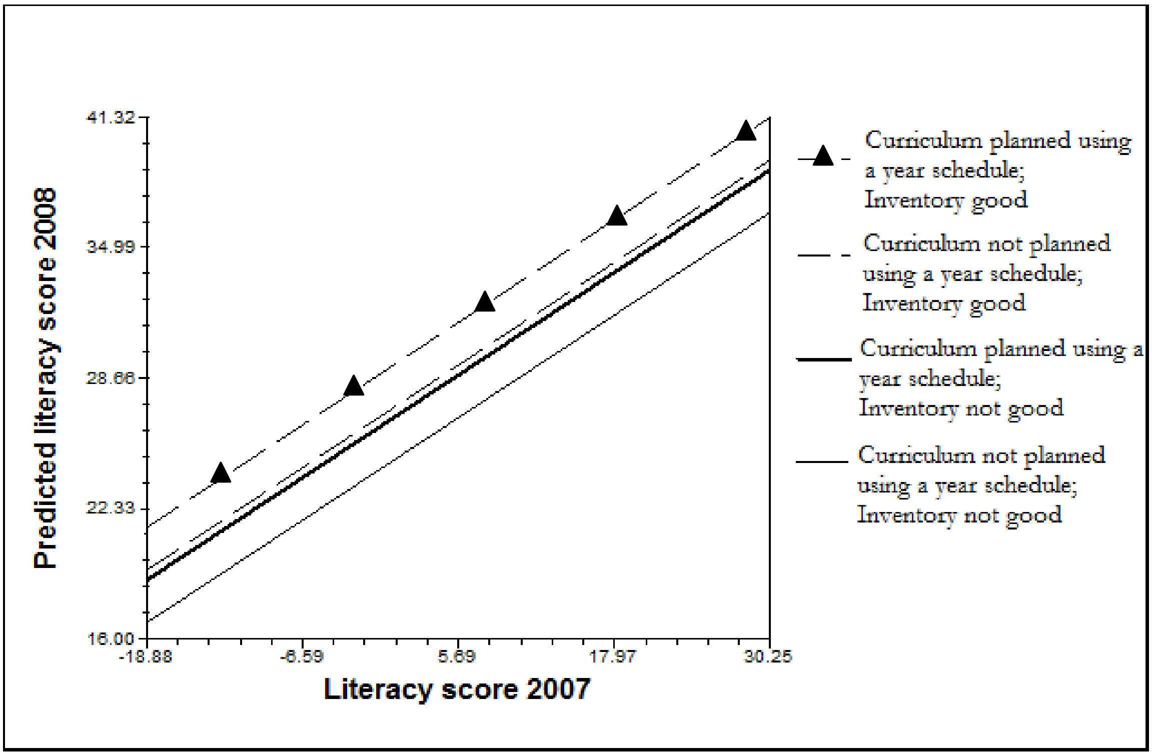
Figure 4.22: Grade 4 literacy achievement by grade 3 achievement and school mean SES



The dummy variable for the presence of a full set of class texts was no longer significantly associated with literacy achievement once grade 3 achievement was controlled for and was therefore not included in the level 2 model. The coefficients on the pupil-teacher ratio and the media and communication facilities index remained statistically significant although the estimated impacts were small. Again, the evidence for the impact of teacher knowledge was weak in terms of statistical significance, but the variable was nonetheless retained in the model as the direction of its impact made intuitive sense.

Apart from school mean SES, the most important determinants of the average achievement of schools according to Table 4.21 were the management efficiency indicators – curriculum planning on the basis of a year schedule, the state of LTSM inventories and the availability of a timetable all registered relatively large estimated effects. The estimated impact of the first two of these characteristics is depicted in Figure 4.23. The figure shows that, at given levels of grade 3 achievement, the difference in grade 4 achievement attributable to curriculum planning and the state of LTSM inventories is just less than 5 percentage points. This effect is of a similar magnitude to that of a change in school SES from the 25th to the 75th percentile. This attests that although school SES has a dominant impact on educational outcomes, sound management can still make a significant difference to student achievement.

Figure 4.23: Grade 4 literacy achievement by grade 3 achievement and management characteristics



The HLM model for numeracy excluding the grade 3 scores is presented in Table 4.22. The same set of student characteristics was again found to best explain within-school variation. Although the coefficient on school mean SES in the model for the intercept was not of a negligible magnitude, it was not statistically significant. This may be attributable to the fact that many of the other school and teacher characteristics in the model are distributed along socio-economic lines. Thus, it may be these factors, which are more favourable in high SES schools, that impact on achievement, rather than school SES itself.

Two school resource measures (pupil-teacher ratio and media and communication facilities) emerged with fairly large estimated effects. The three indicators of management efficiency (curriculum planning with a year schedule, the state of inventories and the availability of a timetable) were also strongly associated with achievement. Several variables from the teacher questionnaire were found to be associated with numeracy achievement in this model. Teacher knowledge, the reported number of hours spent teaching during the school week as well as curriculum coverage as indicated by the number of mathematics topics covered and by the number of complex mathematics exercises all were significantly associated with numeracy achievement.

Table 4.22: HLM model for Numeracy in grade 4 (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	36.06***
School mean SES	1.21
Pupil-teacher ratio	-0.61***
Media and Communication facilities index	3.77***
Curriculum planned using year schedule	4.09**
LTSM Inventory average	-3.98*
LTSM Inventory poor	-4.49~
No timetable available	-8.50**
Maths teacher test score: 100%	5.74~
Time spent teaching: 10 to 18 hours	3.49
Time spent teaching: 19 to 26 hours	7.54**
Time spent teaching: more than 26 hours	7.91*
Maths topics covered: 10 to 25	0.80
Maths topics covered: 25 plus	6.48**
Number of complex maths exercises: 18 plus	5.90*
Student SES	0.32
Male	-0.77*
Young	1.09*
Old	-4.03***
Household size: large	-1.46**
Read 1 to 3 times a week	2.16***
Read more than 3 times	3.14***
Speak English 1-3 times	1.91***
Speak English 4+	0.87
English on TV 1-3 times	0.47
English on TV 4+	4.03***

Random effects	**Variance Components**
Intercept, µ0j	120.91***
Level-1 error, rij (σ^2)	193.32

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

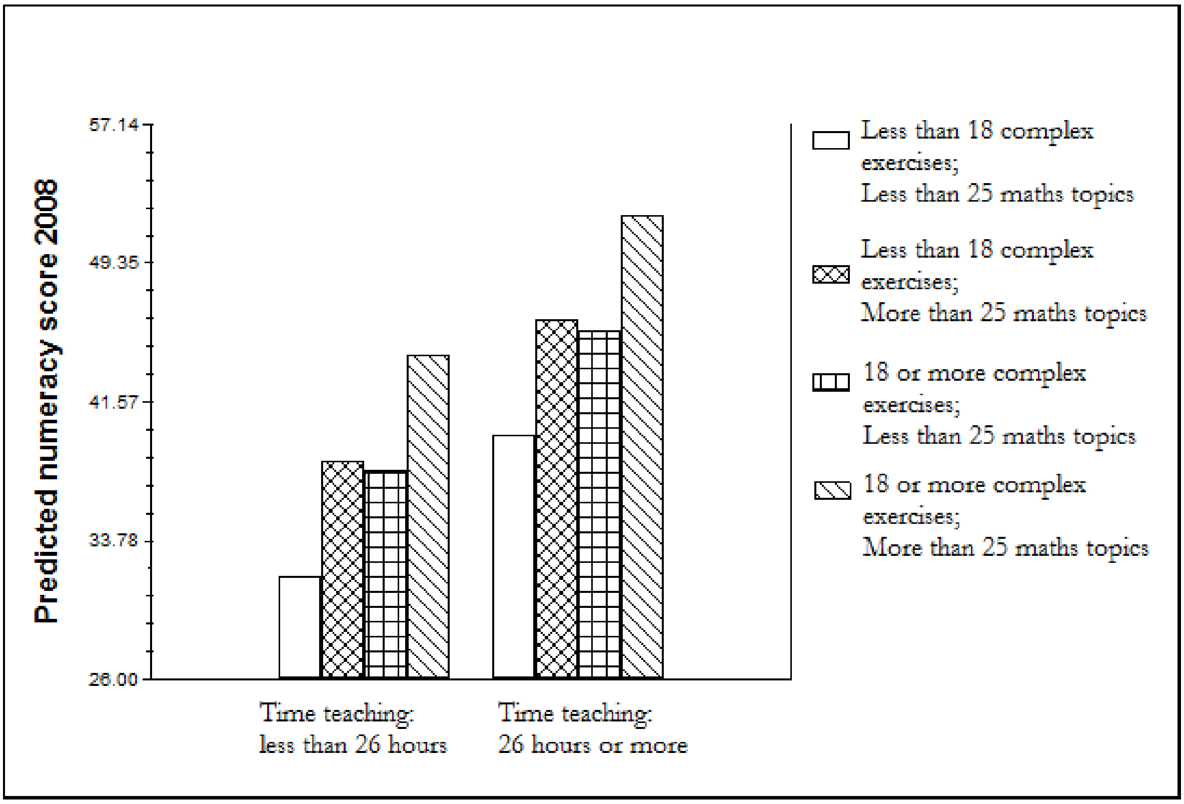
Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, whether curriculum planning happened using a year schedule, Mathematics teacher test scores, time spent teaching per week, the number of mathematics topics covered and the frequency of complex exercises. Table A.21 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.54
Proportion of within-school variance explained by the model = 0.06
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.50

The relative estimated effects of these variables, excluding teacher knowledge, are shown in Figure 4.24. It can be seen that the difference in the predicted numeracy achievement between being in a class where the teacher spent more than 26 hours a week teaching, covered more than 25 topics and dispensed at least 18 complex exercises and being in a class where these characteristics are the opposite, amounts to approximately 20 percentage points. This is a very large magnitude and should not be interpreted as the improvement that schools could expect if they got these three issues right. Rather, this should be taken as evidence that the underlying concepts for which these variables proxy, such as time on task and curriculum coverage, make a substantial difference to student achievement.

Figure 4.24: Predicted numeracy achievement by time spent teaching, the number of mathematics topics and the number of complex exercises



The value-added HLM numeracy model is shown in Table 4.23. The within-school model followed much the same pattern as the previous models. The between-school model was also broadly similar to the numeracy model excluding grade 3 scores, although the number of mathematics topics covered and number of complex exercises were no longer significant once grade 3 scores were included in the model. The overall model fit improved with the inclusion of grade 3 achievement. About 25% of the within-school variation was explained by the model and about 70% of the between-school variation was accounted for.

Table 4.23: HLM model for Numeracy in grade 4 (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	35.15***
School mean SES	1.75~
Pupil-teacher ratio	-0.36***
Media and Communication facilities index	1.49~
Curriculum planned using year schedule	2.75*
No timetable available	-8.68***
Maths teacher test score: 100%	4.06*
Time spent teaching: 10 to 18 hours	-0.13
Time spent teaching: 19 to 26 hours	3.47~
Time spent teaching: more than 26 hours	5.26*
Numeracy score 2007 (grade 3)	0.46***
Student SES	0.10
Male	-0.66*
Young	1.00**
Old	-3.21***
Household size: large	-1.30**
Read 1 to 3 times a week	1.36**
Read more than 3 times	1.83**
Speak English 1-3 times	1.56***
Speak English 4+	0.80
English on TV 1-3 times	0.28
English on TV 4+	2.94***

Random effects	**Variance Components**
Intercept, $\mu 0j$	71.78***
Level-1 error, rij (σ^2)	155.22

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

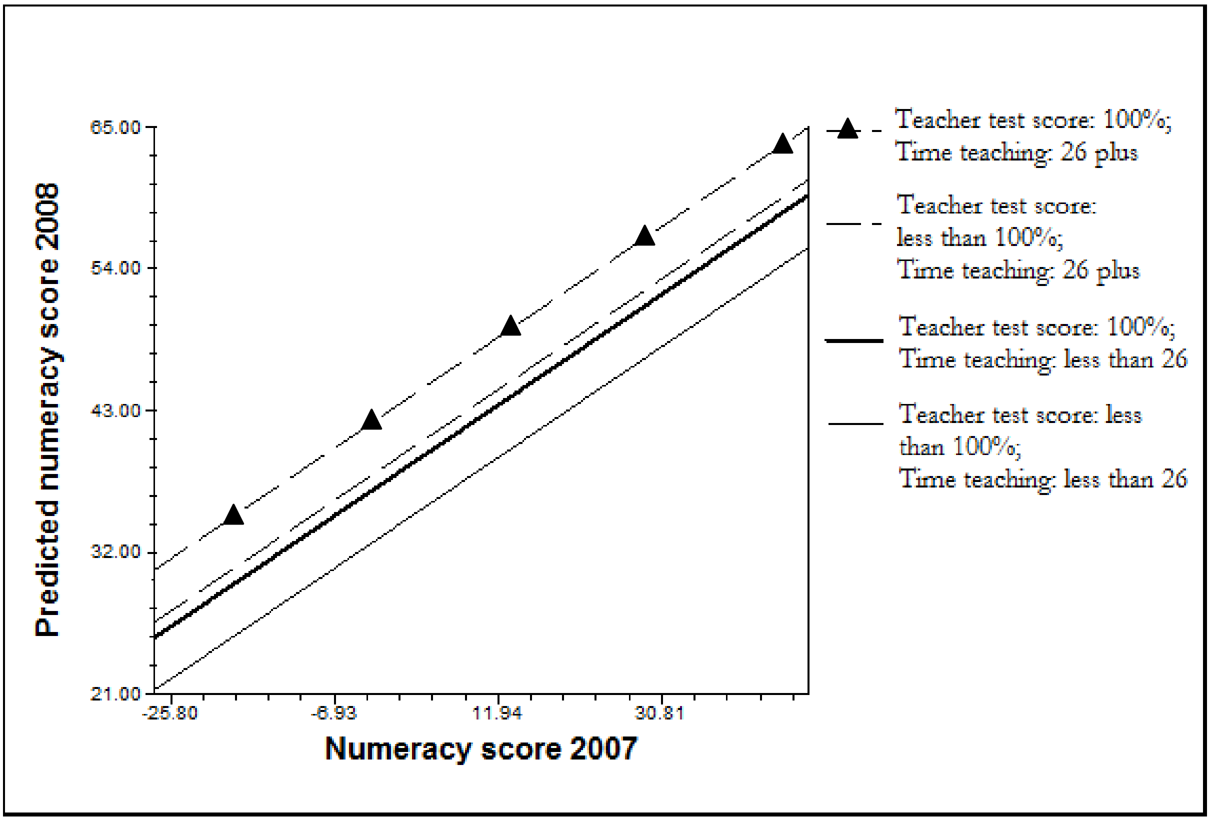
Table Notes:

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, whether curriculum planning happened using a year schedule, Mathematics teacher test scores and time spent teaching per week. Table A.22 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.54
Proportion of within-school variance explained by the model = 0.25
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.70

Figure 4.25 depicts the estimated impact of teacher knowledge and time spent teaching under the value-added model for numeracy. The figure shows that students with teachers who scored 100% on the teacher mathematics test and taught for more than 26 hours a week enjoyed an advantage in the predicted grade 4 achievement of approximately 9 percentage points over students with the same grade 3 numeracy score but with teachers who scored less than 100% and spent less time teaching.

Figure 4.25: Predicted numeracy achievement by teacher knowledge and time spent teaching



The HLM models in this section have confirmed that achievement differences between schools are attributable to school SES, several resource measures to some extent, management efficiency to a greater extent, and teacher effectiveness comprising elements such as subject knowledge, time on task and curriculum coverage. As was done using OLS, separate HLM models were estimated for the sub-sample of historically black schools in order to test which of these factors predict achievement in this critical section of the school system.

4.5.2.2) HLM Models for historically black schools only

The *rho* values for the historically black sample reveal that between 30% and 50% of the overall variation in achievement within this sample was attributable to between-school variation, as Table 4.24 shows. This is small in comparison with the large between-school variation that is reflected in the *rho* values for the entire South African sample, which includes the historically different parts of the system.

Table 4.24: Rho values for the historically black sample

	rho value
Literacy 2007	0.39
Literacy 2008	0.32
Numeracy 2007	0.50
Numeracy 2008	0.39

The value-added HLM for literacy within historically black schools is presented in Table 4.25.[63] The same student characteristics as those included in the HLMs for the full South African sample predicted within-school differences in achievement, although the coefficients were generally smaller than they were in the models for the full sample. This is consistent with the findings in the previous chapter, where smaller returns to characteristics were observed within African language schools when modelling reading achievement in PIRLS. This section of the school system appears less effective at converting normally advantageous student characteristics into higher achievement than the historically privileged part of the system.

While school mean SES and the pupil-teacher ratio were not significantly associated with achievement, the most important factors in the between-school model can be collectively grouped as management efficiency indicators. One variable that did not appear important in the HLM models for the full sample, but which was significantly associated with achievement here, was the dummy for having no teachers absent on the day of the survey. The estimated effects of the state of LTSM inventories were consistent in magnitude and direction with other estimates in this chapter and only just missed out on statistical significance at the conventional levels. These

[63] The HLM without grade 3 scores amongst the explanatory variables is shown in Table A.23 in Appendix J.

variables were therefore retained in the model. Curriculum planning with a year schedule and the availability of a timetable were also associated with achievement in this restricted model.

Table 4.25: HLM model for Literacy in grade 4 amongst historically black schools (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	23.33***
School mean SES	1.20
Pupil-teacher ratio	-0.07
Curriculum planned using year schedule	1.36~
LTSM Inventory average	-1.14
LTSM Inventory poor	-1.19
No timetable available	-2.11~
Teacher absenteeism zero	1.93*
Literacy score 2007 (grade 3)	0.38***
Student SES	0.15
Male	-1.61***
Young	0.39
Old	-2.57***
Household size: large	-0.55~
Read 1 to 3 times a week	0.39
Read more than 3 times	1.04~
Speak English 1-3 times	1.49***
Speak English 4+	0.82
English on TV 1-3 times	0.37
English on TV 4+	2.11***

Random effects	**Variance Components**
Intercept, $\mu 0j$	20.40***
Level-1 error, rij (σ^2)	75.75

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

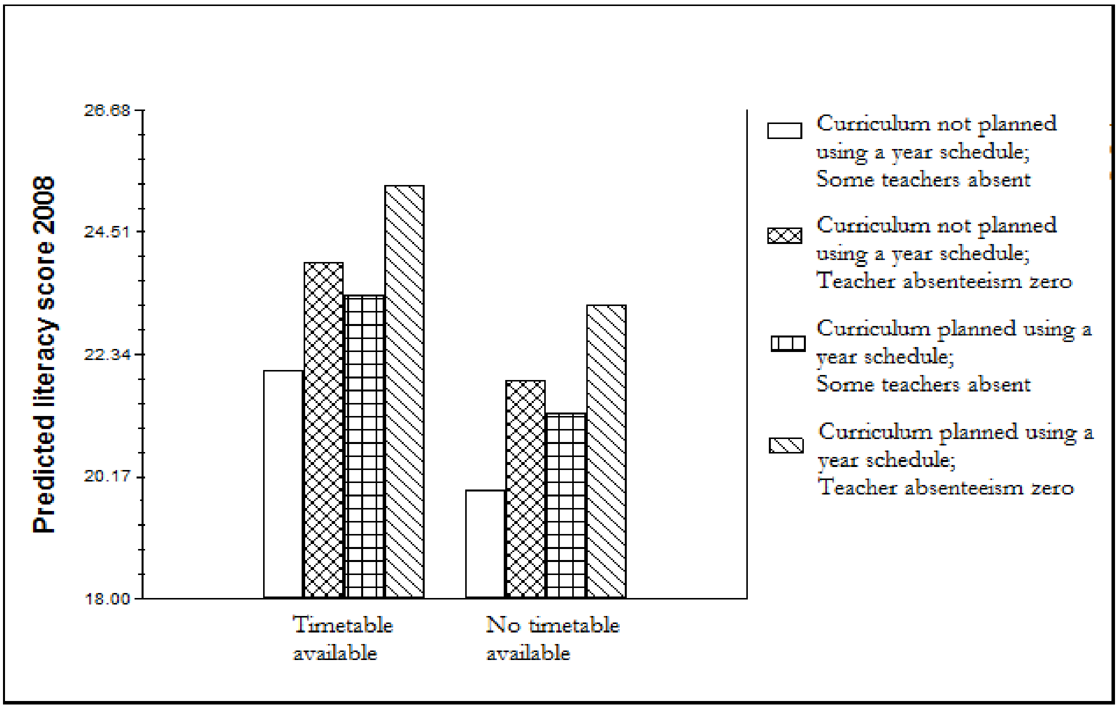
Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV and teacher absenteeism. Table A.24 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.32
Proportion of within-school variance explained by the model = 0.17
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.52

The relative effects of the curriculum planning, teacher absenteeism and timetable availability variables are depicted in Figure 4.26. The magnitude of these estimated effects is evidently somewhat smaller than those obtained in the full sample HLMs. The difference in predicted student achievement between schools in which these three management characteristics were favourable and those which registered negative values was approximately 5 percentage points. Considering that this effect is relative to a very low level of performance, it can be regarded as substantial. Even within the historically black school system, aspects of school management and professionalism impact on student achievement in important ways.

Figure 4.26: Predicted literacy achievement by several management efficiency indicators (under the model for historically black schools)



Zero teacher absenteeism was associated with an even larger effect in the value-added HLM for numeracy amongst historically black schools, presented in Table 4.26.[64] Lower scores in the teacher mathematics test were associated with lower student achievement, although the effect of teacher scores of 1 or 2 out of 5 was not statistically significant. The time spent teaching and

[64] The HLM without grade 3 scores amongst the explanatory variables is shown in Table A.25 in Appendix J.

Table 4.26: HLM model for Numeracy in grade 4 amongst historically black schools (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	30.42***
School mean SES	0.11
Pupil-teacher ratio	-0.13
No timetable available	-4.72*
Teacher absenteeism zero	4.33*
Maths teacher test score: 1 out of 5	-0.27
Maths teacher test score: 2 out of 5	-4.57
Maths teacher test score: 3 out of 5	-6.14*
Maths teacher test score: 4 out of 5	-4.56~
Time spent teaching: 19 to 26 hours	2.53~
Time spent teaching: more than 26 hours	2.75
Maths topics covered: 10 to 25	0.40
Maths topics covered: 25 plus	3.56*
Numeracy score 2007 (grade 3)	0.45***
Male	-0.75*
Young	0.81~
Old	-2.88***
Household size: large	-0.95*
Read 1 to 3 times a week	1.12*
Read more than 3 times	1.39*
Speak English 1-3 times	1.54**
Speak English 4+	0.01
English on TV 1-3 times	0.25
English on TV 4+	2.77***

Random effects	**Variance Components**
Intercept, $\mu 0j$	60.56***
Level-1 error, rij (σ^2)	143.75

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

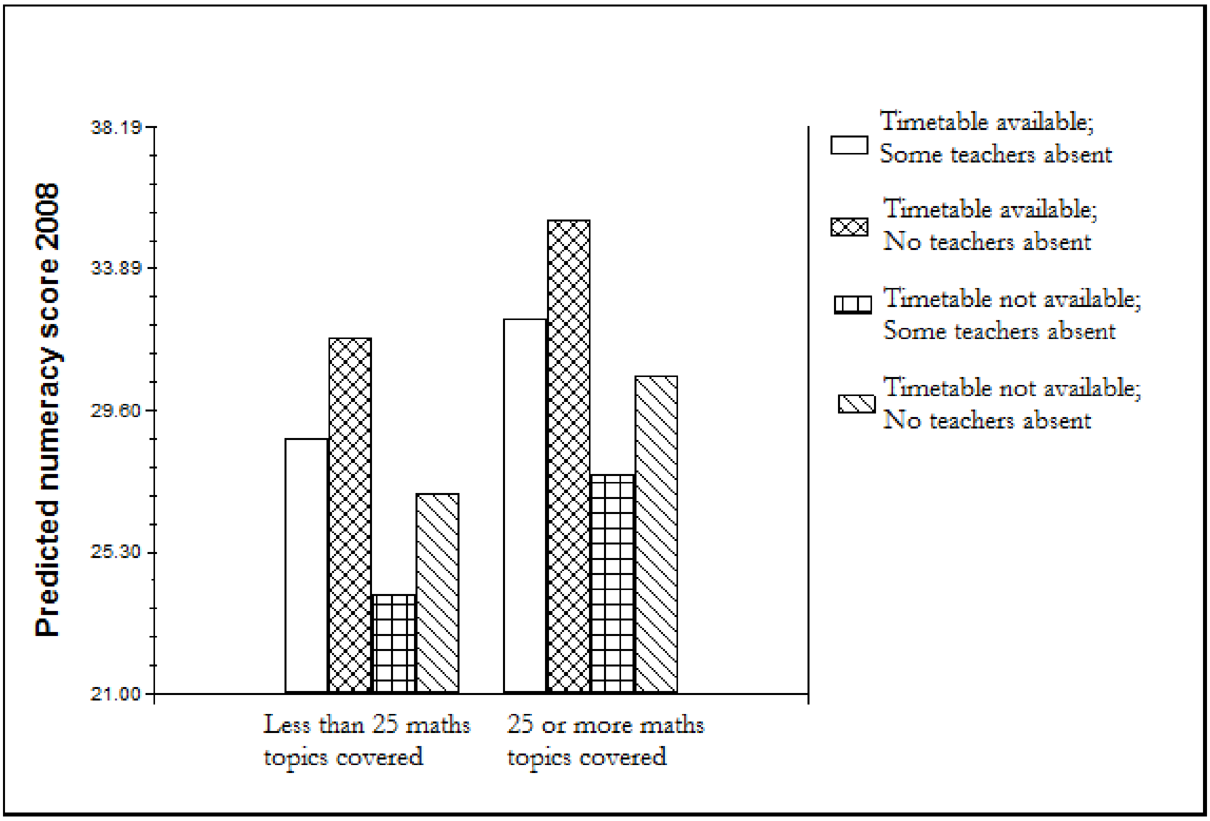
Table Notes:

Dummy variables controlling for non-response were included for the following characteristics: household size, frequency of reading at home on one's own, frequency of speaking English at home, frequency of hearing English on TV, teacher absenteeism, mathematics teacher test scores, time spent teaching per week and the number of topics covered. Table A.26 in Appendix J reports the complete model statistics with the coefficients on these additional variables.

Rho value (ICC) = 0.39
Proportion of within-school variance explained by the model = 0.24
Proportion of between-school variance in β_0 explained by the model = 0.50

number of topics covered again emerged as significant predictors of numeracy achievement within this group of schools. The estimated effects of the number of mathematics topics, the timetable dummy and the teacher absenteeism dummy under the model in Table 4.26 are shown graphically in Figure 4.27. This visual portrayal demonstrates that relatively large achievement gaps exist on the basis of these aspects of management and curriculum coverage.

Figure 4.27: Predicted numeracy achievement by several management and teacher variables (under the model for historically black schools)



A number of indicators of effective management and teaching have emerged throughout this section, and most of these have been shown to apply within historically black schools, a sub-sample for which it is usually particularly difficult to identify factors that are significantly associated with educational achievement. The final section of this chapter adopts a less conventional approach to further examine some of these indicators.

4.6) Evidence from the subjective judgement of fieldworkers

Those who have done fieldwork research in South African schools will know that upon visiting a school one quickly develops a general impression of the overall functionality of that school through interactions with the principal, the level of the school's preparedness for the survey and numerous other conscious and subconscious observations throughout the school day. In the light of this, fieldworkers in the NSES recorded their subjective assessment of the overall functionality of each school they visited. There were 5 response options ranging from "very poor" to "very good." Table 4.27 shows the number of schools falling into each category together with the average literacy and numeracy achievement for each category.

Table 4.27: Average literacy and numeracy achievement in schools by subjective functionality

Subjective functionality	Average school literacy 2008	Average school numeracy 2008	Number of schools
Very poor	23.53	31.60	19
Poor	22.00	28.37	38
Mixed	24.30	31.64	75
Good	25.76	33.77	81
Very good	39.83	54.07	41
Total	26.84	35.41	254

The table demonstrates that both literacy and numeracy achievement was much the same across the categories – with the exception of the "very good" category. Schools in this last category did achieve substantially higher scores on average. This pattern mirrors that which was evident in achievement by quintile of school SES, as depicted earlier in Table 4.1, where average numeracy and literacy achievement remained similar across the bottom four quintiles but was substantially higher for the top quintile of schools.

The remainder of this section investigates what indicators of management efficiency are correlated with the subjective measure of school functionality. The analysis is restricted to historically black schools in order to remove the dominant effect of the outlying historically white schools and to ensure that the results are applicable to this very pertinent section of the school system. In the tables to follow, the 5 categories of functionality were grouped to form a binary outcome variable. The bottom three categories were grouped under "low functionality" and the top two categories were grouped under "high functionality." Table 4.28 shows that the "high functionality" group comprised more affluent schools on average, although the difference in school mean SES between these two groups was not very large. The subjective measure of functionality can therefore not simply be put down to differences in SES.

Table 4.28: School mean SES by subjective functionality in historically black schools

Subjective functionality	School mean SES	Number of schools
Low	1.54	123
High	1.87	82
Total	1.67	205

Table 4.29 shows a clear pattern in curriculum coverage by the subjective measure of functionality. More than 41% of "high functionality" schools covered at least 25 mathematics topics, according to what was seen in student workbooks. In contrast, only about 15% of "low functionality" schools covered more than 25 mathematics topics. This would confirm that effective curriculum coverage distinguishes well-functioning schools from poorly functioning ones.

Table 4.29: The number of maths topics covered by subjective functionality in historically black schools

Subjective functionality	Less than 25 maths topics	More than 25 maths topics	Total
Low	104	19	123
	(84.55%)	(15.45%)	(100%)
High	48	34	82
	(58.54%)	(41.46%)	(100%)
Total	152	53	205
	(74.15%)	(25.85%)	(100%)

Note: Row percentages in parentheses below the frequency

Teacher absenteeism also differed noticeably across the two categories of subjective functionality, as Table 4.30 shows. Roughly half of the "high functionality" schools had no teachers absent on the day of the survey. On the other hand, less than a quarter of "low functionality" schools had zero teacher absenteeism. It is once again evident that this very simple measure is capturing an important dynamic.

Table 4.30: Teacher absenteeism on the day of survey by subjective functionality in historically black schools

Subjective functionality	Some teachers absent	No teachers absent	Total
Low	93	30	123
	(75.61%)	(24.39%)	(100%)
High	42	40	82
	(51.22%)	(48.78%)	(100%)
Total	135	70	205
	(65.85%)	(34.15%)	(100%)

Note: Row percentages in parentheses below the frequency

One variable which did not prove to be significantly associated with achievement in the multivariate models reported in this chapter, but which was more common amongst "high functionality" schools than amongst "low functionality" schools, was the practice of internal monitoring of curriculum coverage through the checking of student workbooks. This practice was reported in about 75% of "high functionality" schools, but about 59% of "low functionality" schools.

Table 4.31: Internal monitoring through checking student workbooks by subjective functionality in historically black schools

Subjective functionality	No Monitoring through checking workbooks	Monitoring through checking workbooks	Total
Low	50	73	123
	(40.65%)	(59.35%)	(100%)
High	20	62	82
	(24.39%)	(75.61%)	(100%)
Total	70	135	205
	(34.15%)	(65.85%)	(100%)

Note: Row percentages in parentheses below the frequency

Another variable pertaining to curriculum management and which was fairly consistently associated with literacy and numeracy achievement in the multivariate analysis was the dummy for whether or not curriculum planning was undertaken using a year schedule. About 63% of "high functionality" historically black schools reported doing this, compared with about 46% of "low functionality" schools.

Table 4.32: Curriculum planning using a year schedule by subjective functionality

Subjective functionality	Curriculum not planned using year schedule	Curriculum planned using year schedule	Total
Low	67	56	123
	(54.47)	(45.53)	(100)
High	30	52	82
	(36.59)	(63.41)	(100)
Total	97	108	205
	(47.32)	(52.68)	(100)

Note: Row percentages in parentheses below the frequency

One way to put these factors together in a multivariate framework is to estimate a probit regression with the binary version of subjective functionality as the dependent variable. Table 4.33 presents two such probit models – one for the full sample of South African schools and one for historically black schools only.[65] Mean school SES was included in both models as a control variable and was found to be significantly associated with school functionality. The marginal effects are reported in the table below.

Table 4.33: Probit models predicting subjective school functionality

	Full sample of schools		Historically black schools only	
Maths topics covered: 25 plus	0.29***	(0.07)	0.26**	(0.08)
Mean School SES	0.10*	(0.05)	0.11*	(0.05)
Curriculum planned using year schedule	0.19**	(0.07)	0.15*	(0.07)
Teacher absenteeism zero	0.17*	(0.07)	0.22**	(0.08)
Monitoring through checking workbooks	0.15*	(0.07)	0.14~	(0.07)
Historically black school (dummy)	-0.19~	(0.11)		
R-squared statistic	0.2095		0.1472	
N	255		205	

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Note: Marginal effects reported; Robust standard errors in parentheses

[65] As schools are the units of analysis it is not possible to include student characteristics amongst the independent variables.

According to these probit models, having covered more than 25 mathematics topics, planning the curriculum using a year schedule, zero teacher absenteeism and monitoring curriculum coverage through checking student workbooks all raised the probability of falling within the subjectively perceived "high functionality" category. These effects were obtained in both models, demonstrating that these indicators of school management not only distinguish between the historically different parts of the school system but also distinguish schools of varying functionality within the historically disadvantaged sub-section. The significant negative effect associated with the "historically black school" dummy in the model for the full sample probably reflects other unobserved aspects of school functionality that are less well realised within those schools. This brief analysis serves to strengthen the case that has been built throughout the multivariate modelling, namely that various indicators of effective school management can be identified in the NSES data and that these shed light on the often difficult-to-observe processes that go on within schools.

4.7) Chapter summary

This chapter has highlighted several indicators of effective school management and teacher practice that are associated with student achievement, even within the large historically disadvantaged and currently underperforming section of the school system. This constitutes an advance on earlier analyses which speculated about the importance of management efficiency but were limited in their ability to identify specific elements thereof.

In particular, this section has found weak evidence that school resources such as pupil-teacher ratios, class texts and media and communication facilities improve student achievement. Similarly, teacher knowledge was not consistently associated with achievement, although the evidence was stronger in the case of numeracy than for literacy. The results pertaining to variables that can be considered indicators of management effectiveness were clearer. An organised learning environment signified by curriculum planning for the full year, a functional timetable, good-quality inventories for LTSM, low teacher absenteeism and up-to-date assessment records were all strongly linked to better student achievement, even after accounting for differences in previous student performance and SES. Key aspects of teacher practice were also illuminated. Numeracy achievement was shown to benefit from regular assessment. The review of student workbooks revealed that curriculum coverage differs markedly across South

African schools and has an important impact on student performance. A conservative and preferred interpretation of these results is to regard such factors as indicators of the type of management and teacher practices that mark effective schools rather than as inputs which can simply be manipulated by policy to guarantee dramatic improvements in educational outcomes.

CHAPTER 5: HOW WELL DO SOUTH AFRICAN SCHOOLS CONVERT GRADE 8 ACHIEVEMENT INTO MATRIC ACHIEVEMENT?[66]

Chapters 3 and 4 examined student achievement at the primary school level. In Chapter 3 the focus was largely on the effects of SES on achievement, with some multivariate analysis which sought to identify school and teacher characteristics that explained achievement. The rich collection of information in the NSES allowed this search for important school and teacher factors to be more productive through further analysis in Chapter 4. The other significant advantage of the NSES was that it was a panel study – the same individuals were tested a year apart. This chapter uses a slightly different sort of panel dataset and the focus shifts from primary to secondary schooling.

5.1) The "TIMSS-matric" dataset

The Human Sciences Research Council (HSRC) co-ordinated and managed the South African part of TIMSS 2002.[67] This tested grade 8 students in mathematics and science. The HSRC subsequently generated a type of panel dataset by extracting information about these same students from the matric datasets of 2006 and 2007. The HSRC collaborated with the University of Stellenbosch on the analysis of this data. By virtue of this collaboration, the author had access to a range of confidential information that was not contained in the publicly available version of TIMSS as released by the IEA. The resulting dataset has two notable and unique features, which are the focus of much of the analysis in this chapter.

Firstly, the data include information on the race group of each student that participated in TIMSS in 2002 as well as the former education department that each school would have belonged to under apartheid. It may seem inappropriate to focus on these categories. However, as argued in the preceding chapters, these historically different systems continue to perform at very different levels and under a different set of processes, i.e. different data generating processes

[66] This chapter builds on joint research undertaken by the author together with Servaas van der Berg, of the University of Stellenbosch, Dean Janse van Rensburg and Vijay Reddy of the HSRC.

[67] A total of 46 countries participated in the 2002 round of TIMSS, which tested grade 4 and grade 8 students in mathematics and science. In South Africa only grade 8 students participated. Although the International Association for the Evaluation of Educational Achievement (IEA) released the data in 2003, and it is therefore often referred to as TIMSS 2003, the fieldwork took place in 2002.

are operating. It is therefore pertinent to reinsert these categories into an analysis of South Africa's educational achievement.

The second unique aspect of the data is that a type of panel has been created. In 2002 TIMSS surveyed 8,952 grade 8 students in 255 schools in South Africa. Using personal details about these students retained by the HSRC, it was possible to identify 2,734 of these students in matric in 2006 or 2007 (or both in the case of repetition). The official matric data for these years were used for this purpose. The new combined dataset thus contains information about mathematics and science achievement at grade 8 level as well as a large range of student, home, teacher and school characteristics as collected in TIMSS 2002. It also contains information about matric subject choice, final matric result (pass category) and total marks achieved in matric English, mathematics and science for those students that were successfully identified in matric.

Numerous questions can now be investigated for which previously existing datasets were not suitable. It is now possible, for example, to explore patterns in subject choice based on previous achievement. This is especially relevant regarding the decision to take mathematics to matric. It is also possible to test how accurately grade 8 achievement predicts various aspects of matric performance. Furthermore, one can consider how well different parts of the school system are able to convert grade 8 achievement into matric achievement.

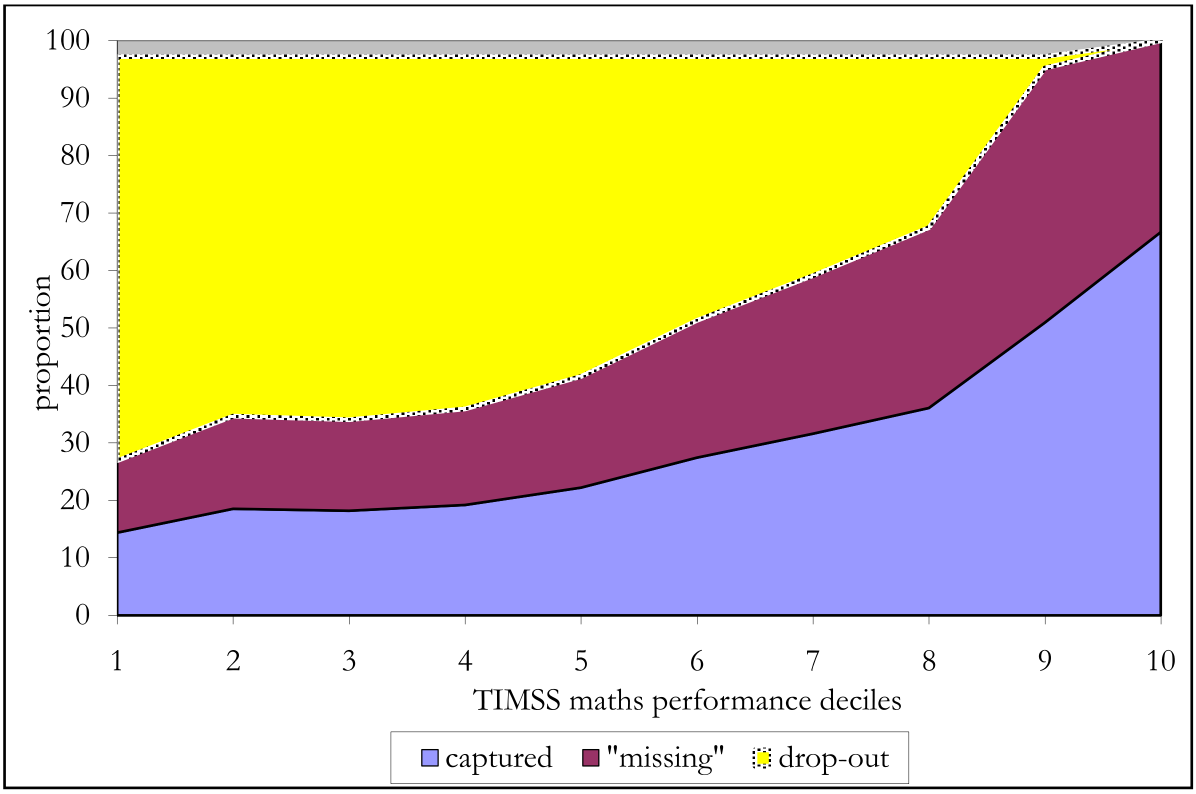
Despite the considerable advantages of this dataset, it presents some rather challenging sample selection issues. These arise because those students who participated in TIMSS but were not identified in matric in 2006 or 2007 were not identified for one of two reasons, and it is impossible to know which reason applies. They were not identified either because they dropped out of school (or repeated more than once before matric) or because they did in fact reach matric but were not identified for reasons relating to the difficult process of identification (e.g. an error in their personal details in either the TIMSS or matric data). Although it cannot be determined which individuals dropped out and which were "missed", so to speak, it is possible to estimate the overall proportions that were "missed" and that dropped out. According to the General Household Surveys (GHS) of 2005 and 2006 approximately 42.90% of South Africans entering grade 8 drop out before reaching matric.[68] Because 30.54% of the original TIMSS

[68] Only people between the ages of 20 and 25 were included in this calculation in order to achieve an up-to-date estimation.

sample was indeed successfully captured in matric it can be reasonably estimated that the remaining 69.46% not identified consists of 42.90% that dropped out and 26.56% that did reach matric but were "missed" in the identification process.

The proportions of the total grade 8 sample that were successfully captured in matric, that reached matric but were "missed" and that dropped out can also be estimated across varying levels of TIMSS performance. Dividing the distribution of TIMSS mathematics scores into deciles, it can be observed how many students were successfully identified in each decile. The proportion of each original TIMSS performance decile that was successfully identified in matric is depicted by the bottom area of Figure 5.1. As the graph indicates, the "capturing rate" increased from 14% within the lowest performing decile to 67% within the top decile.

Figure 5.1: Estimated follow through, drop out and "missed" by TIMSS performance



If it is assumed that the "missing" of individuals who did in fact follow through to matric was a random process, then the ratio of those "missed" relative to those captured in matric could be expected to be relatively stable across the distribution of TIMSS performance. This ratio is thus: 26.56% / 30.54% = 0.8697 or 86.97%. The middle area of Figure 5.1 is therefore given by

86.97% of those captured in each decile (the bottom area). The remaining proportion is then the estimated drop-out within each decile of TIMSS mathematics performance. The exception to this is the top performing decile where 66.7% were captured in matric. 86.97% of this is 58%, which together with the proportion captured already yields over 100%. Thus it was assumed that no drop-out occurred amongst this group of students.

There is reason to expect that some bias in the non-identification of students was at work and, therefore, that the proportion of those "missed" relative to those captured was not exactly constant across the TIMSS distribution. For example, it may have been that students at the lower end of the TIMSS distribution would have been more likely to make errors in completing personal details, or similarly that organisational inefficiency in less well-performing schools led to incomplete or inaccurate information relevant to the identification of individuals in matric. It is however unlikely that any such biases in "missing" matriculants would drastically alter the basic picture offered by Figure 5.1. The figure therefore remains a useful representation of the drop-out that occurs between grade 8 and matric.

The so-called capturing rate differed substantially by race. Only about a quarter of the black students that participated in TIMSS were identified in matric, whereas nearly three quarters of white students were. It is well known that the level of dropping out differs considerably across the race groups in South Africa, as the GHS estimates confirm. However, the capturing rates were not symmetrical with the expected follow through rates for each race, as Table 5.1 shows. In the analysis to follow in this chapter, therefore, separate weights for each race were applied in order to weight up those captured in matric and weight down those not identified. The weighting procedure is outlined in Appendix K.

Table 5.1: Capturing rate by race

	TIMSS full sample	Captured in matric	Capturing rate	GHS follow through rate
Black	7329	1857	25.34%	55.34%
Coloured	1053	497	47.20%	53.56%
Indian	153	72	47.06%	88.08%
White	417	308	73.86%	86.65%
Total	8952	2734	30.54%	57.1%

5.2: Results: Predicting matric performance based on grade 8 achievement

The exercise of tracking the performance of students over a period of time holds potential to bring out important implications for the key question of this thesis, namely "what role is the school system playing in South Africa's economic development?" If educational inequalities on the basis of SES are reduced as students progress through school then the school system can indeed be regarded as a potential pathway out of poverty. However, if those from poor backgrounds exit school with educational outcomes that leave them vulnerable upon entering the labour market, then the school system has merely served to reproduce existing patterns of socio-economic inequality.

Due to the hierarchical nature of learning (new knowledge and skills build upon existing knowledge and skills)[69] it is important to know how the effect of SES operates at different stages in the trajectory of schooling and the extent to which schools are able to influence student achievement at different stages in the trajectory of schooling. If the negative effects of low SES lead to learning deficits upon exiting primary school that secondary schools are unable to reverse, a strong case would exist for interventions at the primary school level and before. On the other hand, if effective secondary schools are able to raise educational achievement significantly despite working off a low base, it would become important to establish which parts of the school system are most effective at converting initial achievement into matric performance and which school characteristics enhance this conversion. These are important empirical questions that will be addressed in this chapter by examining how South African schools convert grade 8 achievement into matric performance.

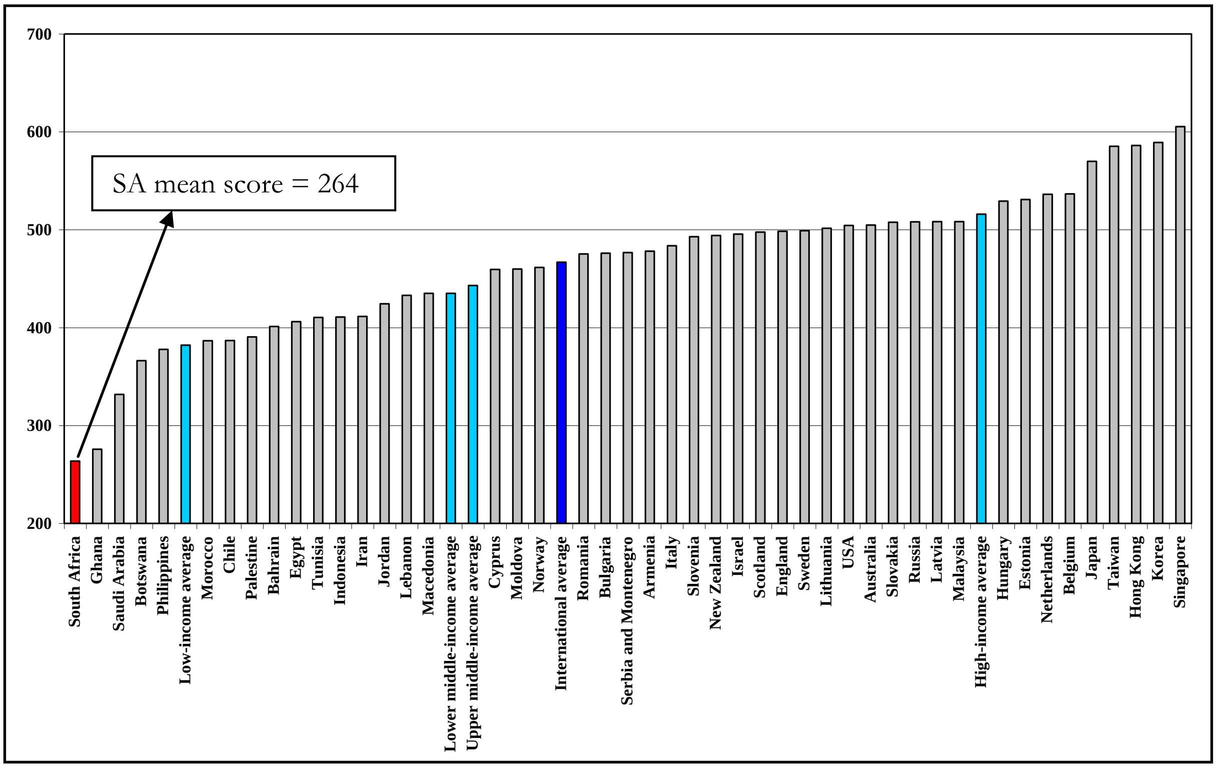
5.2.1) The relationship between TIMSS performance and follow-through to matric

As was the case in PIRLS, the overall performance of South African children in TIMSS was very low. South Africa achieved the lowest mean score in both mathematics and science out of a sample that included six African countries. The South African mathematics and science averages were each more than two standard deviations below the international average. Figure 5.2 presents the average mathematics scores for all the participants as well as the mean scores for

[69] The hierarchical nature of learning as espoused by Heckman (2006) was discussed in Chapter 2.

high income countries, upper-middle income countries, lower-middle income countries and low income countries, according to World Bank classifications.

Figure 5.2: National average scores for mathematics in TIMSS 2002



Note: The scale is set to have an international mean of 500 and standard deviation of 100.

The type of panel dataset that was created contains three categories of matric cohort, so to speak: those students who were not identified in matric, those who were identified in matric in 2006 and those who were identified in matric in 2007.[70] Table 5.2 reports the size of these various groups and how they had performed in TIMSS when they were in the eighth grade.[71]

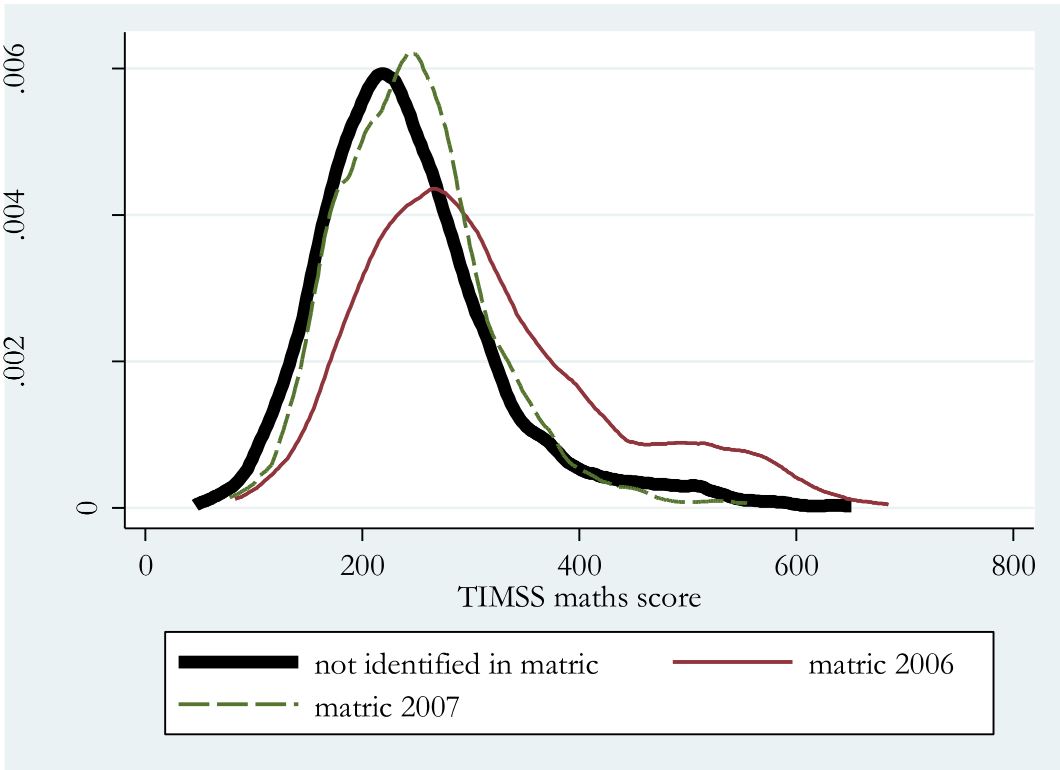
[70] There were 213 students that repeated matric and were therefore identified in both the 2006 and 2007 cohorts. According to the matric datasets, 83 of these students had in fact passed in 2006 and evidently repeated in 2007 for some reason other than failure in 2006. The performance of these 83 students in 2007 was therefore omitted from the analysis.
[71] The TIMSS scores for mathematics and for science are scale average scores set to have an international mean of 500 and a standard deviation of 100 points.

Table 5.2: TIMSS mathematics scores by identification and matric cohort

	Mean TIMSS maths score	Observations
Not identified	242.64	6218
Identified (2006 & 2007)	294.85	2734
Matric 2006	310.76	2031
Matric 2007	251.55	833
Total	263.61	8952

As might be expected, the group that reached matric without repeating (that wrote matric in 2006) had performed better on average in mathematics in grade 8. Their mean score was nearly 70 points higher than that of the group not identified in matric, and nearly 60 points higher than the 2007 cohort's. It is interesting that the average TIMSS mathematics score for the 2007 matriculants was not much higher than for the group of students that were not identified in matric. Figure 5.3 illustrates, using kernel density curves, how similar the TIMSS performance distribution for these two groups is.

Figure 5.3: Kernel density of TIMSS mathematics by identification and matric year



As the figure shows, the mode of the distribution for those who wrote matric in 2006 lies to the right of the other two groups and there is also a greater concentration of relatively high TIMSS scores, indicated by the fatter right hand tail. Thus it can be said that this group had performed noticeably better than the other groups in grade 8. However, it is evident that the distribution of TIMSS scores for the matric 2007 group lies only slightly to the right of that for the group that was not tracked to matric. There are at least two possible reasons for this. It could be that there is no substantial difference between eighth graders who will end up dropping out of school prior to reaching matric and those who remain in the system until matric but take an extra year to get there. Alternatively, the distribution for those not identified could hide two underlying distributions: a distribution of mainly low TIMSS scores by students who did in reality drop out of school and a group of students who actually reached matric but were "missed" in the identification process and had done somewhat better in TIMSS. The right hand tail of the distribution for those not identified is somewhat fatter than that for the matric 2007 cohort, a feature probably attributable to the group of "missed" students. However, the modes of these two distributions are so close and the shape of the two curves so similar for the most part that it would seem that the first of the two proposed reasons is the more dominant: there was little difference in grade 8 achievement between students who dropped out of school and students who reached matric with a delay.

There are intriguing differences in these follow-through patterns across the various former education departments, as Table 5.3 shows. Within historically black (DET) schools the difference in TIMSS scores between students who wrote matric in 2006 and those who wrote a year later was only about 24 points on average. Within the other categories of former department the difference in grade 8 achievement between these two cohorts was much more substantial, nearly 70 points within formerly HOA schools, for example. It is also striking that those in formerly coloured, Indian and white schools who wrote matric in 2007 or were not tracked to matric had performed considerably better than students in historically black schools who wrote matric in 2006. Taken together, these patterns may suggest that grade 8 achievement (as measured in TIMSS) was a fairly accurate sorter of ability (proxied for by the likelihood of reaching matric) within formerly HOR, HOD and HOA schools, but did not sort very cleanly within formerly DET schools.

Table 5.3: Mean TIMSS mathematics scores by ex-department and matric cohort

	Matric 2006	Matric 2007	Not tracked
DET (B)	256.68	232.21	219.97
	(1162)	(620)	(5042)
HOR (C)	367.54	317.83	303.12
	(350)	(122)	(713)
HOD (I)	398.59	308.4	331.48
	(121)	(35)	(150)
HOA (W)	473.29	404.22	422.84
	(398)	(56)	(313)

Note: Number of observations in parentheses

5.2.2) The relationship between TIMSS performance and passing matric

Out of the original 8,952 students participating in TIMSS in 2002, 1,911 were found to pass matric in either 2006 or 2007. 197 students were tracked to matric but cannot be said to have passed or failed, due to missing data or fewer than 6 subjects being taken. This means that 21.83% of those who participated in TIMSS in 2002 were found to have passed matric by 2007. Applying the new weighting to the calculation of this rate (i.e. weighting up those captured and weighting down those not captured, separately for each race group in accordance with expected follow through rates) produced a rate of 39.6%. This "conversion rate" is an estimate of the percentage of South African students reaching grade 8 that go on to pass matric. This estimate is remarkably close to that obtained using the Community Survey (2007) data. According to the Community Survey, 39.7% of South Africans between the ages of 22 and 29 that completed grade 7 went on to complete matric.

Table 5.4 shows the percentage within each matric cohort that passed matric. Unsurprisingly, those who reached matric without repeating any years were a stronger cohort as reflected by the pass rate in matric. Note that in this table individuals who repeated are counted in both cohorts and are double-counted in the total pass rate. An alternative not shown in the table is to calculate a pass rate as those who passed in *either* year divided by the total number of students identified in matric. With the relevant weighting, this yielded a matric pass rate of 72.3%.

Table 5.4: Pass rates in each matric year

Matric year	Pass rate	Observations
2006	78%	1941
2007	48%	661
Total	70%	2602

There are some interesting and important differences in pass rates between the various former education departments, and these will now be a major focus of analysis in this chapter. Table 5.5 reports the conversion rates and pass rates for each race group and former department. The low conversion and pass rates amongst black and coloured students and the corresponding former departments are not surprising given the historical disadvantage and current low SES of these groups.

Table 5.5: Matric "conversion rates" and "pass rates" by race and ex-department (with new weighting)

	Race group*	Ex-department*	Ex-department*[1]
Black/DET	37.51%	33.56%	65.22%
Coloured/HOR	38.31%	36.57%	76.21%
Indian/HOD	87.95%	74.52%	93.18%
White/HOA	84.88%	71.29%	96.61%
Total	39.59%	39.59%	72.28%

***** Pass rate = those passed/original TIMSS sample

***[1]** Pass rate = those passed/total identified in matric

In order to investigate the issue of how the relationship between grade 8 achievement and passing matric differs across the former education departments a probit regression was estimated. The dependent variable took a value of 1 if a student passed matric in either 2006 or 2007, and a value of zero if a student did not pass matric or was not identified in matric. The variables included to predict passing matric were the TIMSS mathematics score in grade 8, dummy variables for each of the former departments and variables interacting former department with TIMSS mathematics score.[72] The results are reported in Table 5.6. Due to the

[72] An asset-based index for student SES, which is described in Section 5.3, did not emerge as a significant predictor of matric pass rates or conversion rates once grade 8 achievement was controlled for and was therefore omitted from this model.

interactions the coefficients are very hard to interpret without plotting the estimated probabilities of passing matric graphically. This is presented in Figure 5.4.

Table 5.6: Probit regression predicting passing matric

(Dependent variable: Pass = 1; No pass = 0)

Explanatory variables	Marginal effects coefficient	Standard error
TIMSS maths score	0.0025**	0.00016
HOR (C)	-0.4055**	0.038
HOD (I)	0.3101*	0.136
HOA (W)	0.4094**	0.091
HOR*TIMSS maths	0.0012**	0.00038
HOD*TIMSS maths	-0.0005	0.00039
HOA*TIMSS maths	-0.0012**	0.00027
Observations	8728	
Pseudo R-squared	0.1361	

*Significant at 5% level **Significant at 1% level

Figure 5.4: Predicted probabilities of passing matric

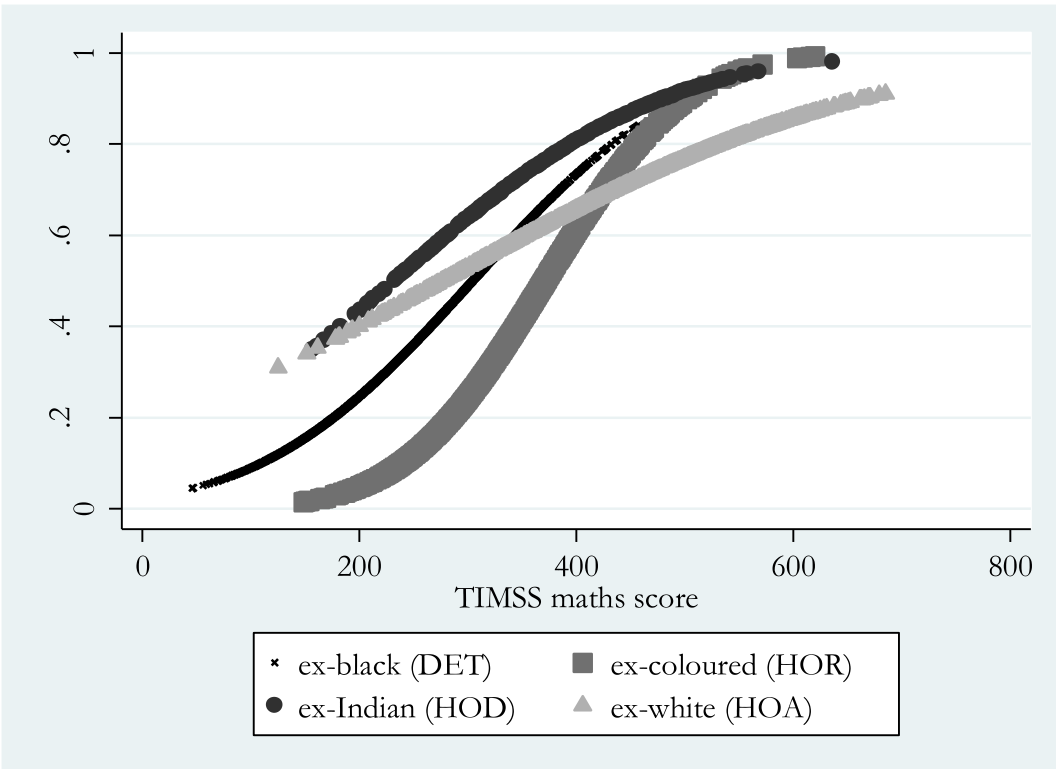


Figure 5.4 is a scatterplot of the predicted probabilities of passing matric across different levels of performance in grade 8. It is evident that the probability of passing matric at given levels of TIMSS performance differed amongst the former education departments. One might think of the differences in the probability of passing for a given level of grade 8 achievement as differences in the ability of the respective school "systems" to convert grade 8 achievement into matric achievement. Two aspects of the figure strike one as surprising and pose challenging questions. First, why does there appear to be better conversion of TIMSS performance into matric passes within ex-HOR (C) schools than ex-HOA (W) schools at the top end of the TIMSS distribution? Second, why does there seem to be better conversion within ex-DET (B) schools than ex-HOR (C) schools at the lower end of the TIMSS distribution, which is where the bulk of students is concentrated?

There are various considerations pertaining to the first question. Firstly, the sample size for ex-HOR schools is rather small at the top of the TIMSS distribution. Only 70 students within ex-HOR schools achieved a score of over 450 in TIMSS. Of these, 54 were identified in matric. Although these are relatively low numbers of students, they were spread across 18 schools. This would suggest that small sample size was not necessarily the main driving force behind the differential conversion at the top end of TIMSS performance.

Secondly, the apparent lower conversion at the top end within ex-HOA schools may be to some extent an artefact of the limited success rate in identifying individuals in matric. 372 students in ex-HOA schools scored over 450 in TIMSS and only 270 of these were identified in matric. Perhaps a substantial number of "missing" individuals in ex-HOA schools who in reality did reach matric is to some extent the factor driving this apparent difference in conversion. It should be noted that when modelling the probability of passing matric *conditional upon reaching matric*, the estimated probability of passing converged towards one at the top end of the TIMSS distribution for students in ex-HOR and ex-HOA schools alike.[73]

A third possible reason for the apparent difference in conversion at the top end is that those few students in ex-HOR schools who did achieve high TIMSS scores may have been particularly motivated or have had especially good home support. It is unlikely that such individuals, who

[73] This probit model and the accompanying scatterplot depicting the predicted probabilities of passing matric is presented in Appendix L.

were motivated enough to reach a high level of achievement by grade 8 despite what may have been an unfavourable school environment, would have then dropped out of school or been poorly prepared for the matric exam.

A fourth possible explanation for the seemingly better conversion at the top end of the distribution within ex-HOR schools relates to what can loosely be termed coaching for assessment. Good "coaching" for assessment involves frequent exposure to good quality assessment together with meaningful feedback to students in order for them to understand what is expected of them. If grade 8 students in ex-HOR schools had been less well coached for assessment than those in ex-HOA schools, then the TIMSS scores may underestimate the true ability of students within ex-HOR schools. It is likely that these schools would have been better able to prepare their students for the matric exam, given the traditional importance of the matric exam in South Africa. Consequently, students in these schools would have performed nearer to their true ability in matric than in TIMSS. Therefore, the estimated probability of passing for a given TIMSS score might be more appropriately associated with a score somewhat to the right (in Figure 5.4) of the registered TIMSS score. For example, the ability of an ex-HOR student that scored 450 in TIMSS may have been better reflected by a score of 500. This might account for the gap between ex-HOR and ex-HOA schools at the top end of the TIMSS distribution.

The second curiosity that is raised by Figure 5.4 is the apparently better conversion of grade 8 achievement into matric passes within ex-DET schools than within ex-HOR schools across the lower and middle parts of the TIMSS distribution. When considering Figure 5.4 it is important to keep in mind where the bulk of the students are concentrated. The median TIMSS score for students in ex-DET schools was 228 and for students in ex-HOR schools was 318, indicating that TIMSS scores for the latter group were concentrated at considerably higher levels. Nevertheless, despite the overall higher level of achievement within ex-HOR schools, it would appear that for a given TIMSS score the probability of passing matric was higher for students in ex-DET schools. This gap in the probability of passing held for the majority of the distribution of TIMSS scores and narrowed towards the higher end. An alternative way of looking at the differences in conversion and at where the bulk of the distribution is concentrated is provided by Figures 5.5 and 5.6. Figure 5.5 depicts the average probability of passing matric, as estimated by the probit model in Table 5.6, for each quintile of performance in TIMSS mathematics and by former department. Figure 5.5 is thus essentially showing the same thing as Figure 5.4 but in a different way. Figure 5.6 shows the simple conversion rates[74] within each decile of TIMSS performance and by former department.

Figure 5.5: Probability of passing matric by TIMSS performance and former department

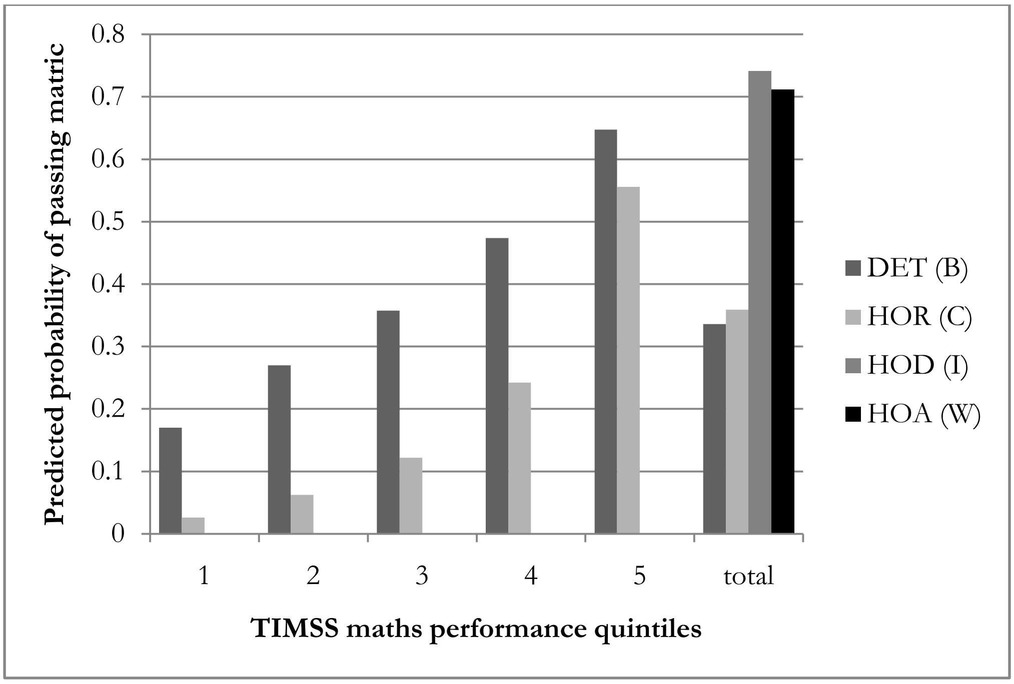
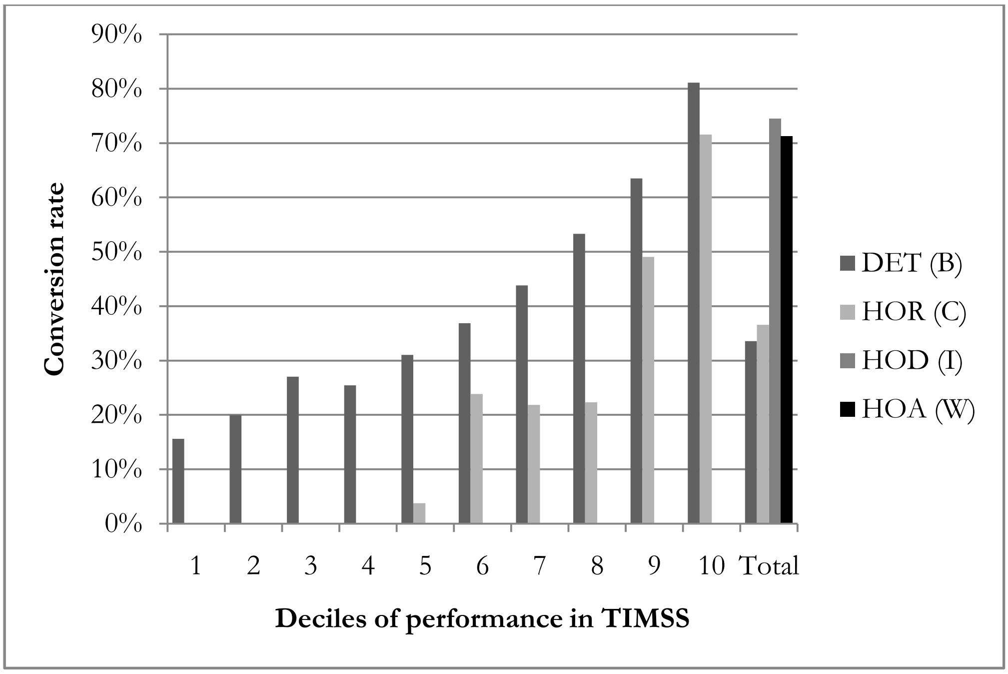


Figure 5.6: Conversion rates by TIMSS performance and former department



74 Conversion rate = number passed / original TIMSS sample

Figures 5.5 and 5.6 reveal that although in each quintile (decile) of TIMSS performance the probability of passing (pass rate) was greater for students in ex-DET schools than ex-HOR schools, yet the overall probability of passing (pass rate) was higher within ex-HOR schools. This ostensible anomaly arises because the bulk of ex-HOR students were located in the upper quintiles (deciles) of TIMSS performance. Note that out of the 77 students in formerly HOR schools in the bottom four deciles only five were identified in matric, and not one of the five passed, which accounts for the zero pass rates for ex-HOR schools within the bottom four deciles. In contrast, approximately 20% of students in ex-DET schools and in the bottom four deciles of TIMSS achievement went on to pass matric. This may indicate that TIMSS was a more accurate sorter of ability amongst students in ex-HOR schools than it was in ex-DET schools.

If the apparent difference in conversion of grade 8 achievement into matric passes constitutes a substantive difference in performance between these two historically different groups of schools, this finding could be taken to be a redeeming one for ex-DET schools, at least at the secondary school level – despite a very low overall level of performance, this group of schools is better at realising matric passes than ex-HOR schools given the level of grade 8 achievement with which they have to work. The difference in conversion might, however, also be capturing a negative process within ex-HOR schools rather than a positive process within ex-DET schools. One factor which may underlie the poor conversion rate within ex-HOR schools is the high rate of drop-out that is known to occur amongst coloured students. Nyanda *et al* (2007: 52) demonstrate that the enrolment rate for coloured youth drops sharply around the ages of 15 and 16, and that this pattern is peculiar to the coloured population. Despite low levels of performance there is a higher rate of retention amongst black youth of high school age. Although this feature of coloured schooling may feed into the lower conversion within ex-HOR schools evident in Figure 5.4, it does not seem to be the whole story. When estimating a probit model predicting the probability of passing matric *conditional upon reaching matric* a similar pattern emerges: at given levels of TIMSS performance, students in ex-DET schools have a higher probability of passing than students in ex-HOR schools, across most of the distribution.[75]

A second hypothesis for why ex-DET schools appeared to convert grade 8 achievement into matric passes better than ex-HOR schools is that students in ex-DET schools had systematically

[75] This probit model and the accompanying scatterplot depicting the predicted probabilities of passing matric is presented in Appendix L.

underperformed in TIMSS, but were able to perform nearer to their true ability in matric. Many black students probably were at a language disadvantage in TIMSS, which was administered in either English or Afrikaans. Consequently, the majority of coloured students would have been tested in their mother tongue while most students in ex-DET schools would not have been. The extent of this language effect factor would probably be less significant in matric, as black students have the opportunity to take their home language as a matric subject, and a strong performance in that subject would feed positively into a student's overall pass result. Table 5.7 demonstrates that students in historically black schools did indeed speak the language of the TIMSS test less frequently on average than those in historically coloured schools. Only 7.4% of students in ex-DET schools reportedly always spoke the language of the test at home. For students in ex-HOR schools this figure was 61.9%. This language disadvantage may well have contributed to a systematic underperformance amongst students in ex-DET schools in TIMSS.

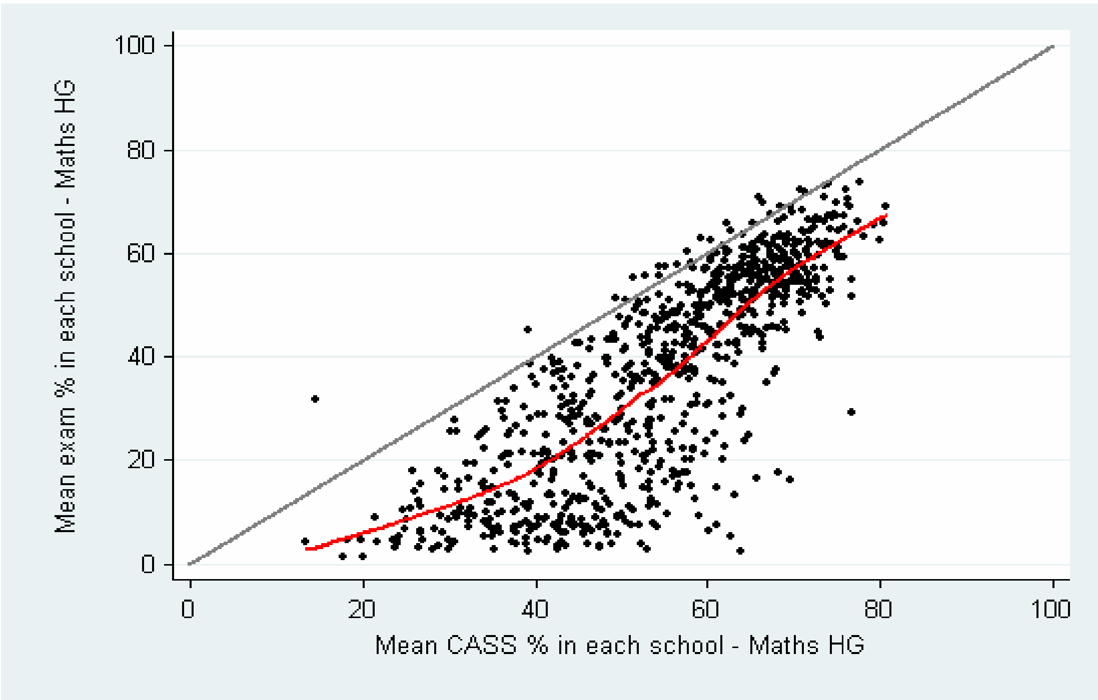
Table 5.7: Frequency of speaking the language of the TIMSS test by former department

	DET (B)	HOR (C)	HOD (I)	HOA (W)	Total
Always	7.4%	61.9%	40.7%	54.8%	18.4%
Almost always	7.0%	11.6%	14.2%	23.5%	9.3%
Sometimes	66.5%	23.7%	42.8%	19.6%	57.0%
Never	19.1%	2.9%	2.4%	2.2%	15.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Another reason to expect systematic underperformance of ex-DET students in TIMSS is that grade 8 students in this part of the system may have been poorly coached for assessment. If students had not routinely been exposed to assessment accompanied by meaningful feedback it is understandable that their performance in a test such as the TIMSS mathematics test would have underestimated their true ability. Recent research has shown that assessment in many of South Africa's schools is weak and provides a rather inaccurate signal to students. Lam *et al* (2008) argue that grade progression amongst black students can be described as something of a lottery. The authors assume that grade progression reflects the true ability of a student as well as a stochastic element linked to factors like the student's form on the day of an exam and inconsistent assessment by teachers. They find that this stochastic component is particularly large amongst black students, implying that in the schools they attend grade progression is weakly linked to actual learning or ability. Lam *et al* (2008: 39) conclude that the ability to assess learning accurately is a critical aspect of school quality that is lacking in many of the schools that black students attend.

Van der Berg and Shepherd (2008) have demonstrated that considerable discrepancies exist between continuous assessment scores, which are determined by schools independently, and matric examination results, which are standardised. Two types of problems with continuous assessment marks are examined in the report by Van der Berg and Shepherd. Firstly, in many schools continuous assessment marks were weakly correlated with matric scores. This means that students received an unreliable signal of their relative performance compared with their classmates. Secondly, Van der Berg and Shepherd point to the problem of assessment leniency. They found that in many schools, especially low performing schools, continuous assessment marks were considerably higher than matric marks. This is described very well by Figure 5.7, which is reproduced from the report of Van der Berg and Shepherd. Each dot in the scatterplot represents one school consisting of at least 15 students. The figure shows that in schools that recorded very low average mathematics HG marks the continuous assessment marks tended to be considerably inflated. Students in schools below the trend line cannot have had an accurate expectation of how well they would perform in the matric examination.

Figure 5.7: Continuous assessment marks and matric mathematics HG 2005 and lowess regression trend line



Source: Van der Berg and Shepherd (2008: 9)

It is reasonable to expect that low quality assessment would be more severe at the grade 8 level than at grade 12, where schools are grooming students for the matric exam in a very focussed manner. Also, in ex-DET schools, effective teachers are often scarce, leading to a concentration of the better teachers in matric due to the high-stakes nature of the matric examination, which may result in weak assessment practices in the lower grades. This would all result in underperformance in TIMSS by students in ex-DET schools.

To summarise, the fact that there appears to be better conversion of grade 8 achievement into matric passes in ex-DET schools may therefore be less of an indication that more actual learning occurred in ex-DET high schools than in ex-HOR high schools, and more a reflection of at least three other factors: a language disadvantage in TIMSS, poor exam writing skill and weak assessment practices prevalent in the historically black part of the school system.

5.2.3) The relationship between TIMSS performance and the decision to take mathematics in matric

The data contains information about matric mathematics, science and English performance, for those students that were identified in matric. The focus in this section will be on the decision to take mathematics in matric. In the next section the performance of students in matric mathematics and English will be examined. Table 5.8 reports the numbers taking mathematics on the standard grade (SG) and higher grade (HG) in each former education department.

Table 5.8: Participation in matric mathematics by former department

	DET (B)	**HOR (C)**	**HOD (I)**	**HOA (W)**	**Total**
No maths	610	289	60	150	1109
	(34.52)	(59.34)	(38.46)	(33.04)	(38.72)
SG	1034	174	65	178	1451
	(58.52)	(35.73)	(41.67)	(39.21)	(50.66)
HG	123	24	31	126	304
	(6.96)	(4.93)	(19.87)	(27.75)	(10.61)
Total	1767	487	156	454	2864
	(100)	(100)	(100)	(100)	(100)

Note: Column percentages in parentheses

Not surprisingly, the proportion of students taking mathematics at the higher grade was greatest within formerly white and Indian schools. Other interesting features of the table include the high proportion of students in ex-DET schools (58.52%) that took mathematics SG, and the high proportion of students in ex-HOR schools (59.34%) that did not take mathematics in matric. To investigate these patterns somewhat further, a probit regression model was estimated, predicting the probability of taking mathematics in matric conditional upon grade 8 performance in TIMSS. The dependent variable took a value of 1 if a student took mathematics in matric and a value of zero if a student did not take mathematics or was not identified in matric. The explanatory variables included the TIMSS mathematics score in grade 8, dummy variables for each of the former departments and variables interacting former department with TIMSS mathematics score. The results are reported in Table 5.9. Again, the coefficients are hard to interpret without plotting the estimated probabilities of taking mathematics on a graph. This is presented in Figure 5.8.

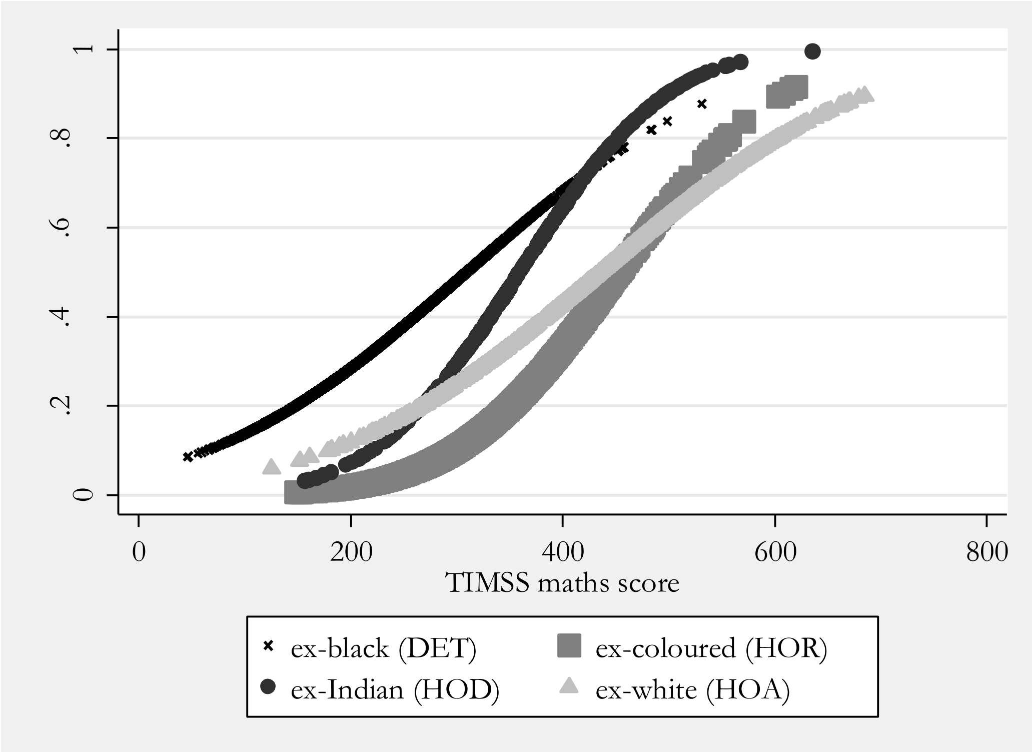
Table 5.9: Probit regression predicting taking mathematics in matric

(Dependent variable: mathematics SG or HG = 1; No mathematics / not identified = 0)

Explanatory variables	Marginal effects Coefficient	Standard error
TIMSS maths score	0.0019**	0.00015
HOR (C)	-0.4225**	0.025
HOD (I)	-0.3663**	0.033
HOA (W)	1.0876*	0.099
HOR*TIMSS maths	0.0011**	0.00042
HOD*TIMSS maths	0.0015**	0.00044
HOA*TIMSS maths	-0.000065	0.0003
Observations	8952	
Pseudo R-squared	0.0945	

*Significant at 5% level **Significant at 1% level

Figure 5.8: Predicted probability of taking mathematics in matric by former department



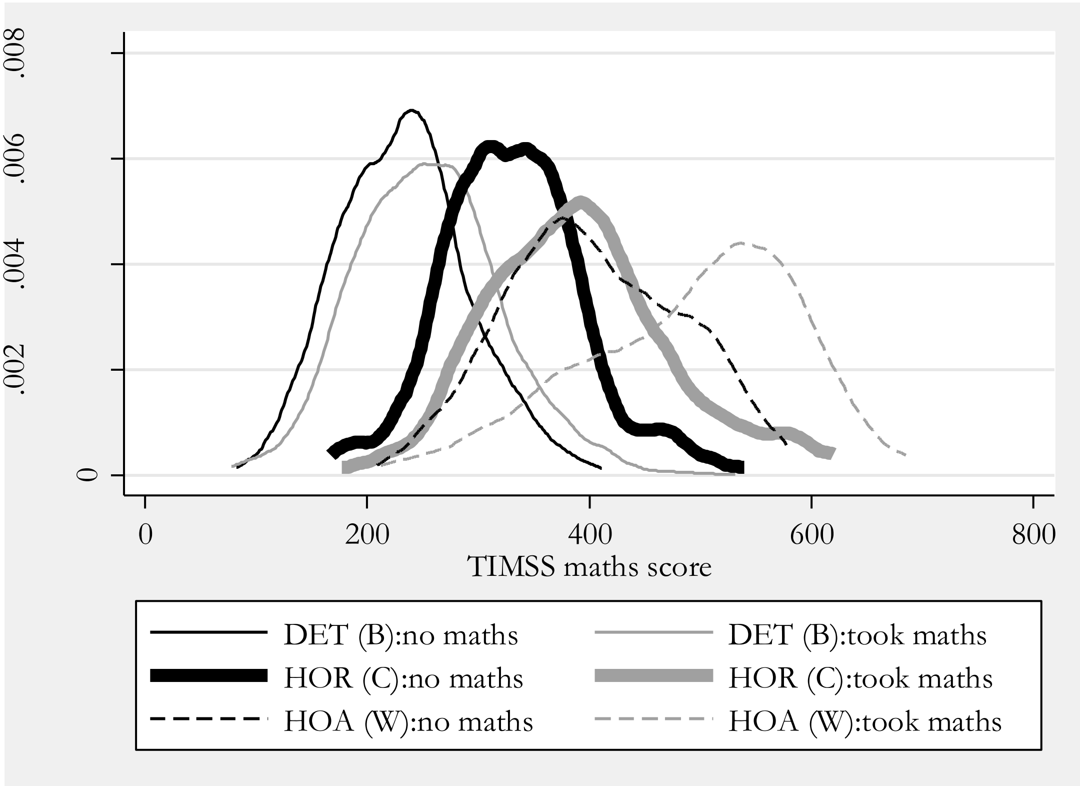
When comparing the probabilities of taking mathematics for ex-DET schools and ex-HOR schools a similar picture emerges to that which came out when comparing the respective probabilities of passing matric for these two groups. At given levels of grade 8 performance, students in ex-DET schools had a greater probability of taking mathematics in matric than students in ex-HOR schools. The difference is considerable – across most of the distribution the difference in the probability of taking mathematics was between 0.2 and 0.4.

The same explanations that were considered with respect to the differential probabilities of passing matric could apply to these differences in the probability of taking mathematics in matric. Figure 5.8 is consistent with the supposition that ex-DET schools were better than the rest at taking medium to low performing grade 8 students and producing suitable matric mathematics candidates. However, this hypothesis seems implausible given what is known about the general level of efficiency of this part of the South African school system. Alternatively, the pattern could be attributable to systematic underperformance in TIMSS amongst students in ex-DET schools. This would mean that these students registered a probability of taking mathematics associated with a mathematical ability tantamount to 20 or 40 points (for argument's sake) higher than their achieved TIMSS scores. Even so, this systematic underperformance can surely not account for the very wide gap in the probability of taking mathematics between ex-DET schools and the other groups.

It is likely that ex-DET and ex-HOR schools differed in important ways in terms of the processes that fed into the decision to take mathematics to matric. The factors involved in this decision making process might include, amongst others, prevalent attitudes toward mathematics, understanding of the standard required for matric, parental influences, the quality of guidance regarding subject choices available to students, or the precision with which schools are able to assess the mathematics ability of their students and hence the quality of information available to students upon which to base their subject choice decisions. Whatever the relevant factors, Figure 5.8 is consistent with the possibility that some students in ex-DET schools who would have been best advised not to choose mathematics for matric were allowed or encouraged to do so or, conversely, that students in ex-HOD schools were overly discouraged from taking mathematics. Out of a potential 300 marks in the case of standard grade mathematics and 400 for higher grade, the average total mathematics mark for ex-HOD students was 114.23 and for ex-DET students was 83.96. The respective modes were even lower due to extreme top end observations raising the mean. These statistics are not impressive for either group of schools. The greater likelihood therefore is that too many students in ex-DET schools took mathematics rather than that too few students in ex-HOR schools chose this subject.

A comparison, separately for each former department, of the distribution of TIMSS achievement for those who took mathematics and those who were identified in matric but did not take mathematics, sheds more light on the issue of subject choice. Figure 5.9 presents this using kernel density curves. It is evident that in the case of historically white and coloured schools, there was a considerable difference between the TIMSS performance of those who took matric mathematics and those who did not. The distribution of TIMSS performance for ex-DET students who took mathematics was, however, very similar to that for those not taking mathematics. This implies that in ex-DET schools, the decision whether or not to take mathematics to matric was largely random and was not strongly determined by actual mathematics competence earlier in high school. Simple probit regressions predicting participation in matric mathematics by TIMSS mathematics score, run separately for each former department, confirmed this.[76] In the model for ex-DET schools, only about 2.5% of the variation in taking mathematics was explained by the TIMSS mathematics score. In contrast, approximately 16% of the variation was explained by the model for ex-HOR schools, approximately 20% was explained by the model for ex-HOA schools and approximately 30% was explained by the model for ex-HOD schools. By comparison then, the decision to take mathematics to matric appeared to have a large random component in historically black schools. This lends weight to the hypothesis that imprecise assessment and (possibly consequential) low quality of guidance regarding subject choices may have led some students in historically black schools to take mathematics when they would have been better advised not to, and perhaps vice versa.

Figure 5.9: Kernel density curves of TIMSS performance by former department and participation in matric maths

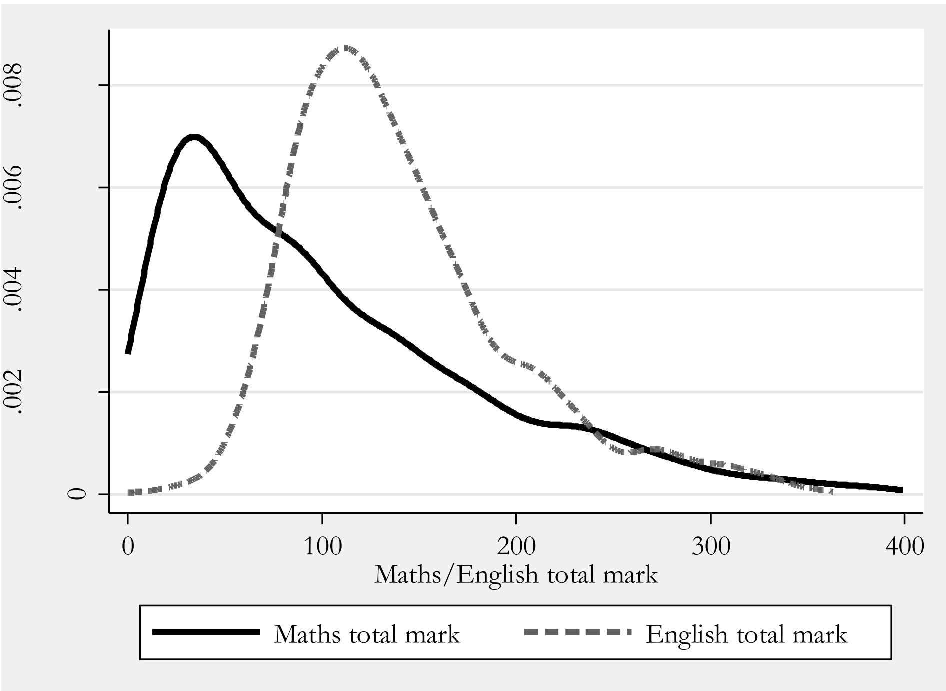


[76] The regression results as well as the numbers of students taking mathematics and not taking mathematics in matric for each former department are presented in Appendix M.

5.2.4) The relationship between TIMSS performance and matric mathematics and English performance

The distributions of performance in matric mathematics and English are displayed using kernel density curves in Figure 5.10. For both subjects the maximum possible mark is 300 marks in the case of standard grade and 400 for higher grade. For the sake of the analysis, scores of those doing standard grade and higher grade were treated as one distribution, based on the assumption that 240 out of 300 for standard grade, for instance, is roughly equivalent (in terms of the underlying mathematics competency it reflects) to 240 out of 400 on the higher grade. It is concerning how far left the modes of these two distributions lie, especially in the case of mathematics. This strengthens the notion that a considerable number of students (mainly in historically black schools) took mathematics despite not having a suitable foundation for doing so.

Figure 5.10: Kernel density curves of matric mathematics and English performance



The scatterplots and lowess smoothing lines in Figures 5.11 and 5.12 provide a visual indication of the association between grade 8 achievement in TIMSS and matric achievement in mathematics and English, respectively. Interestingly, the association between TIMSS mathematics achievement and matric English achievement was stronger than that between TIMSS mathematics and matric mathematics. This is partly evident in the visibly better fit in

Figure 5.12 than in Figure 5.11 and was confirmed by correlation coefficients. The correlation between TIMSS mathematics and matric English was 0.78 compared with 0.62 for that between TIMSS mathematics and matric mathematics. With this in mind it was decided to use the total mark achieved in matric English as the dependent variable for most of the forthcoming analysis. Another consideration was that the sample of students that took English was larger than that which took mathematics.

Figure 5.11: Scatterplot of TIMSS mathematics against matric mathematics and lowess smoothing line

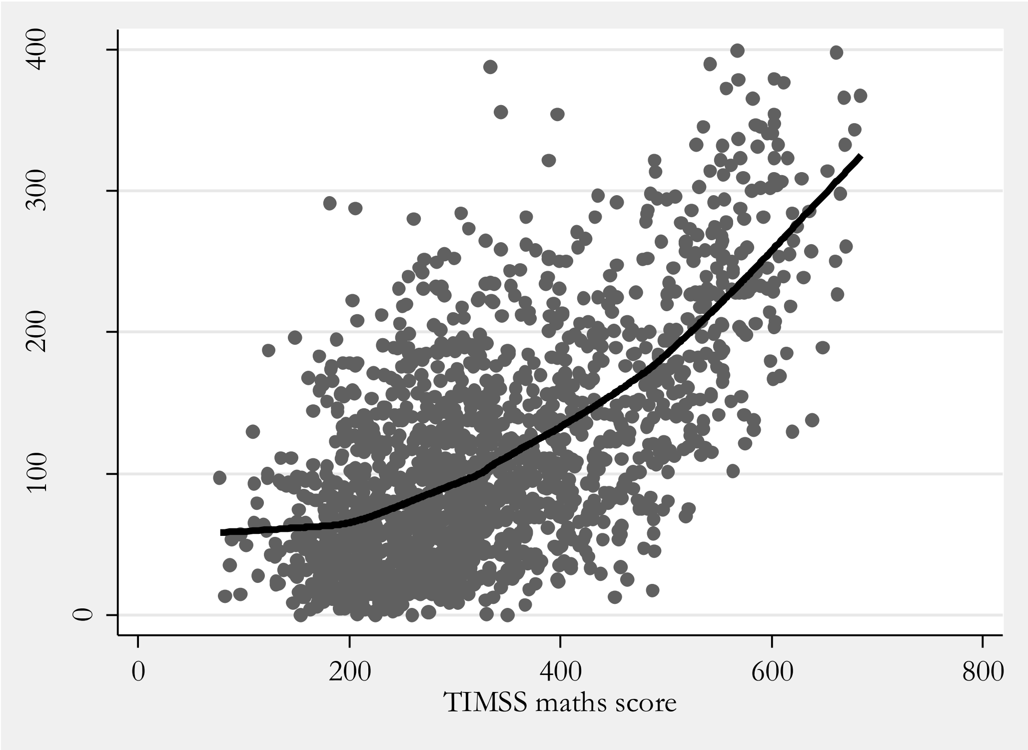


Figure 5.12: Scatterplot of TIMSS mathematics against matric English and lowess smoothing line

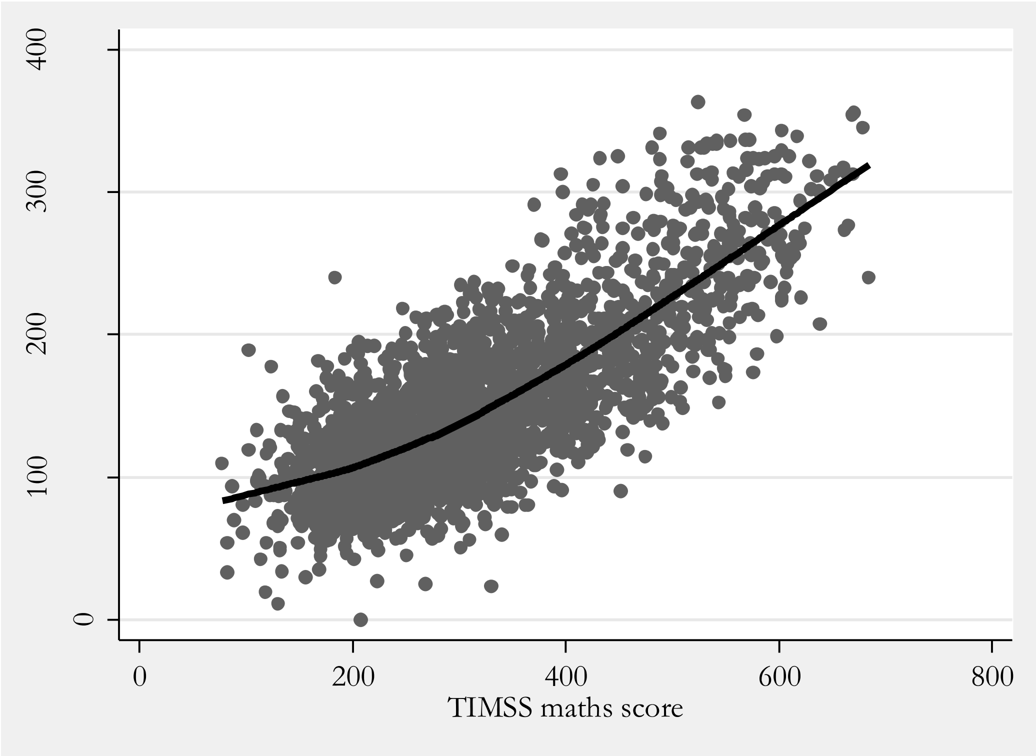


Table 5.10 reports the results from an OLS regression model predicting English total mark in matric by TIMSS mathematics score and its square, former education department and interactions between TIMSS performance and former department. For the sake of interpretation, the predicted English marks for each ex-department are plotted in Figure 5.13. At given levels of grade 8 achievement, students in historically white and Indian schools performed better in matric English than students in historically black and coloured schools. As was the case when looking at the probabilities of passing matric and the probabilities of taking mathematics in matric by former department, historically black schools appeared to convert TIMSS achievement into matric English achievement better than historically coloured schools, although in this case the difference was not statistically significant. It is likely that the superior conversion of grade 8 performance into matric performance within historically white and Indian schools relative to ex-DET schools captures a substantive difference in the relative efficiency at which these two systems operate. However, the apparent advantage in terms of conversion that ex-DET schools held over historically coloured schools is probably due to the hypotheses regarding systematic underperformance in TIMSS due to a language disadvantage in the TIMSS test and weak assessment in historically black schools, as posited earlier.

Table 5.10: OLS regression predicting English performance in matric

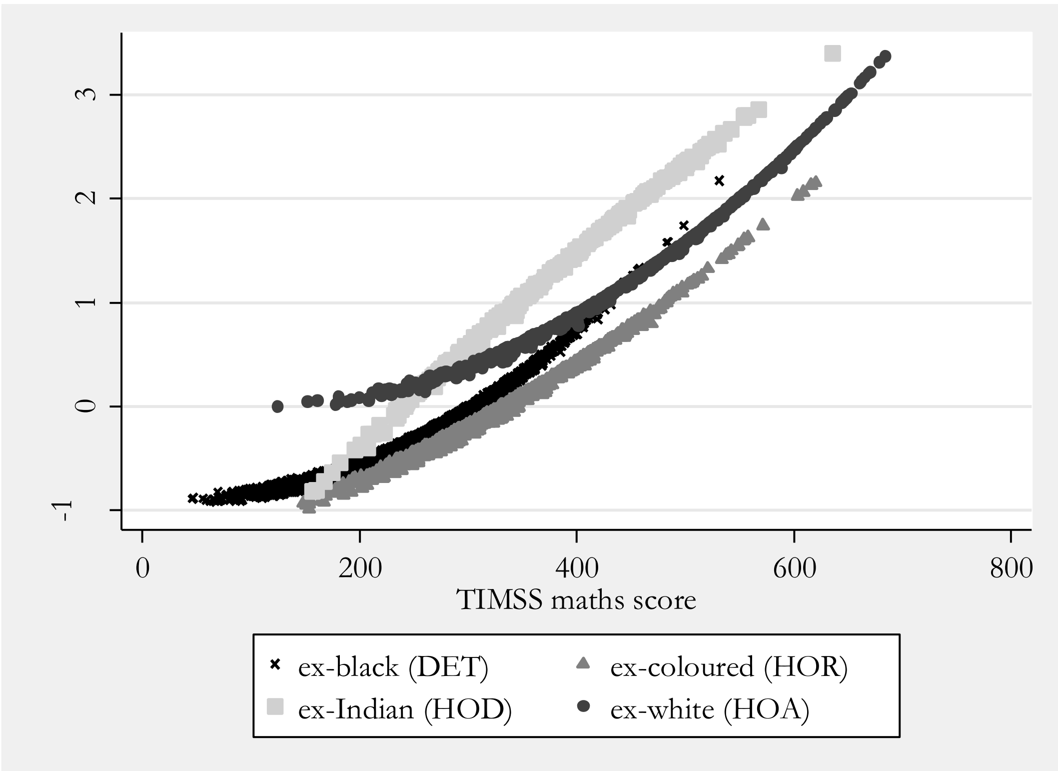
(Dependent variable: English total mark)

Explanatory variables	Coefficient	Z-statistic
TIMSS maths score (std)	0.5321**	20.74
TIMSS score squared	0.1153**	4.47
HOR (C)	-0.1622**	-3.30
HOD (I)	0.4732**	5.51
HOA (W)	0.4837**	3.98
HOR*TIMSS maths	-0.0347	-0.50
HOD*TIMSS maths	0.3727*	2.41
HOA*TIMSS maths	0.2359	-1.83
HOR*TIMSS squared	-0.0666	-1.93
HOD*TIMSS squared	-0.1410*	-2.33
HOA*TIMSS squared	-0.0230	1.92
Mills (λ)	-0.28**	
Constant	-0.2444**	-5.42
Uncensored Observations	2658	

*Significant at 5% level **Significant at 1% level

Note: In an attempt to control for the selection of students into matric a Heckman 2-step procedure was followed. The selection equation was statistically significant, indicated by the statistical significance of lambda (λ) and the variables included were a set of urban/rural dummies, a set of dummy variables for the severity of absenteeism in school, and a dummy taking a value of one if the mathematics teacher in the school was offered any incentives for performance.

Figure 5.13: Predicted English performance by TIMSS achievement and ex-department



Further evidence of the underperformance hypothesis and randomness of assessment in ex-DET schools was obtained by estimating separate OLS regression models (simply predicting matric English mark by TIMSS mathematics score) for ex-DET schools and for the rest of the sample. Just over 51% of the variance in English achievement was explained by the model for "non-DET" schools whereas only about 29% of the variance was explained by the model for ex-DET schools. This is evidence of a large stochastic component in the ex-DET model, indicating that in this group of schools grade 8 assessment was characterised by a considerable amount of randomness.

The notion of systematic underperformance is alternatively described by Figure 5.14, in which separate lowess regressions of matric English total against TIMSS mathematics scores for each former department are presented. In the figure, both TIMSS mathematics scores and matric English marks have been standardised to have a mean of zero and standard deviation of one. Above the mean TIMSS score, in each former department a one standard deviation increase in grade 8 achievement is associated with about a one standard deviation increase in matric English achievement, as indicated by the fact that the slopes are roughly parallel to the 45 degree line. However, below the mean TIMSS score – where the bulk of the students were located in ex-DET schools – the slopes deviate above the 45 degree line. This is exactly to be expected if TIMSS candidates in ex-DET schools did in fact systematically underperform. The very low grade 8 achievement of such candidates is thus an underestimation of their true ability, which is more accurately reflected in their matric English performance.

The story is very similar when looking at the relationship between matric mathematics marks and TIMSS performance. In Figure 5.15 the TIMSS scores of those tracked to matric have been divided into deciles. The bars represent 95% confidence intervals around the mean matric mathematics score for students in ex-DET schools and in ex-HOR schools within each decile of TIMSS performance. Note that no confidence intervals are displayed for ex-HOR schools in the bottom four deciles because there was only one ex-HOR observation in the bottom four deciles. In the upper six deciles, the mean matric mathematics score was higher within ex-DET schools, with the exception of the sixth decile. This corresponds with the pattern that has consistently emerged in this chapter, that although students in historically coloured schools obtained a higher average level of performance than those in historically black schools, given levels of grade 8 achievement were associated with higher matric performance for students in historically black schools.

Figure 5.14: Lowess regressions by former department

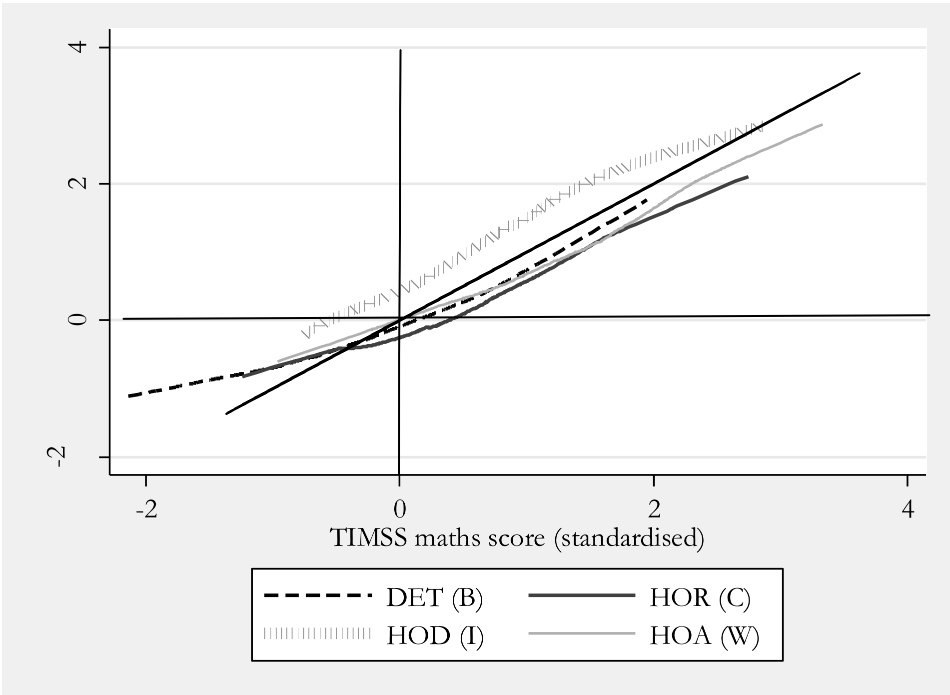
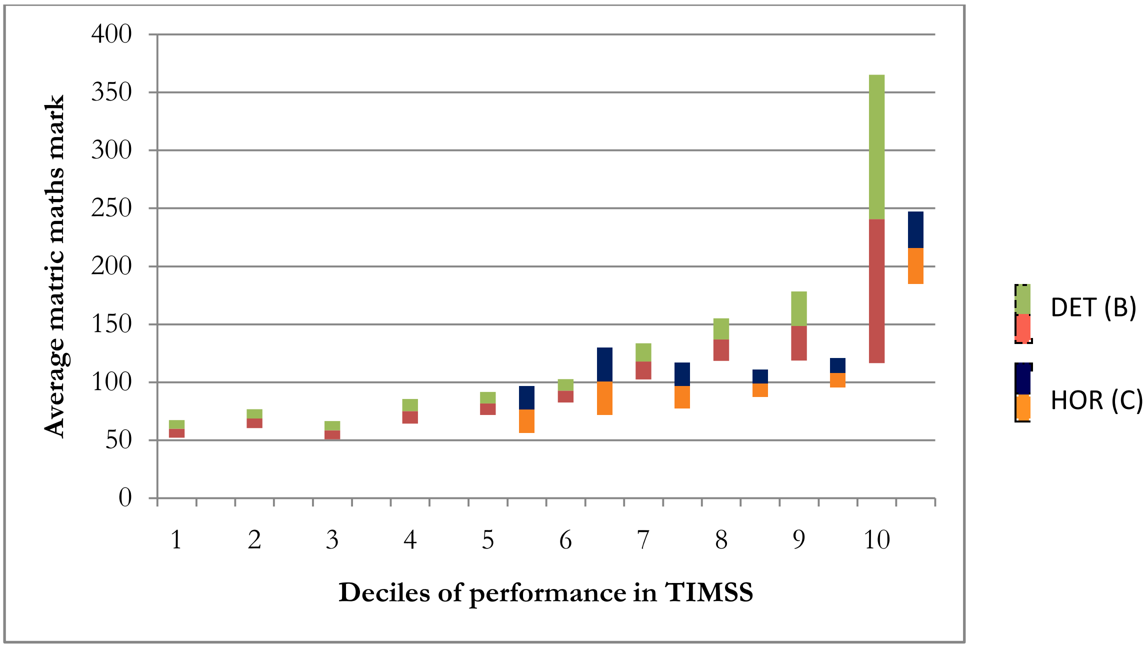


Figure 5.15: Mean matric mathematics mark and 95% confidence intervals by deciles of performance in TIMSS and former department



5.3) The influence of SES and implications for social mobility

In Chapter 3 it was shown that reading achievement amongst South African children differed substantially across the socio-economic spectrum. Considerable use was made of socio-economic gradients to demonstrate this. Applying the same technique to the data here produced the SES gradients depicted in Figure 5.16. The gradients for TIMSS mathematics, matric mathematics and matric English were plotted using the estimates from Regressions [1], [2] and [3] in Table 5.11.[77]

The gradients for TIMSS mathematics and matric English are perhaps most suitable for comparison because the sample of observations is similar, whereas the matric mathematics group was a higher ability sub-sample. For these two gradients a one standard deviation change in SES was associated with a change in predicted achievement of just over half a standard deviation, an effect similar in size to the various estimates obtained in Chapter 3 using the PIRLS data. This means that by grade 8 there are already considerable differences in educational achievement by SES, and that the extent of this effect is similar by matric.

The gradients presented in Figure 5.16 are based on linear estimates of the relationship between SES and educational achievement. In Chapter 3, however, this relationship was shown to be non-linear and convex in the case of South Africa. Figure 5.17 presents socio-economic gradients based on lowess regressions, the locally weighted form of non-parametric regression, which allows the shape of the curve to be determined by the data rather than by a linear or quadratic model specification. The same pattern as that found in Chapter 3 at the 5th grade level is evident at the grade 8 and matric levels. The relationship is essentially flat at low and medium levels of SES, while at high levels of SES a steep curve is observed. As in Figure 5.16, the gradients for grade 8 and matric were very close to each other, indicating that the effect of SES had to a large extent already been established by the 8th grade.

[77] The SES index was derived using the 16 questions in TIMSS regarding the presence of various household items. These 16 items are listed in Appendix D. The same procedure as that applied to construct SES indices in Chapters 3 and 4 was followed here: PCA was applied to the 16 items in order to determine the appropriate weight each item should have in the overall SES index. The index was then standardised to have a mean of zero and a standard deviation of one.

Table 5.11: OLS regression models

Dependent variable	[1] TIMSS maths	[2] Matric maths	[3] Matric English	[4] Matric maths	[5] Matric maths	[6] Matric English	[7] Matric English
Explanatory variables							
SES	0.558 (42.44)**	0.328 (11.95)**	0.511 (24.24)**		-0.087 (3.06)**		0.075 (4.28)**
TIMSS maths				0.516 (27.09)**	0.563 (22.63)**	0.701 (50.08)**	0.660 (38.86)**
constant	-0.017 (1.49)	-0.156 (5.76)**	-0.169 (8.71)**	-0.309 (13.20)**	-0.310 (13.22)**	-0.301 (20.40)**	-0.301 (20.57)**
R-squared	0.2941	0.1144	0.2701	0.3847	0.3906	0.6112	0.6213
Observations	8851	1670	2626	1683	1670	2658	2626

*Significant at the 5% level **Significant at the 1% level

Absolute values of t-statistics in parentheses

Figure 5.16: Linear SES gradients

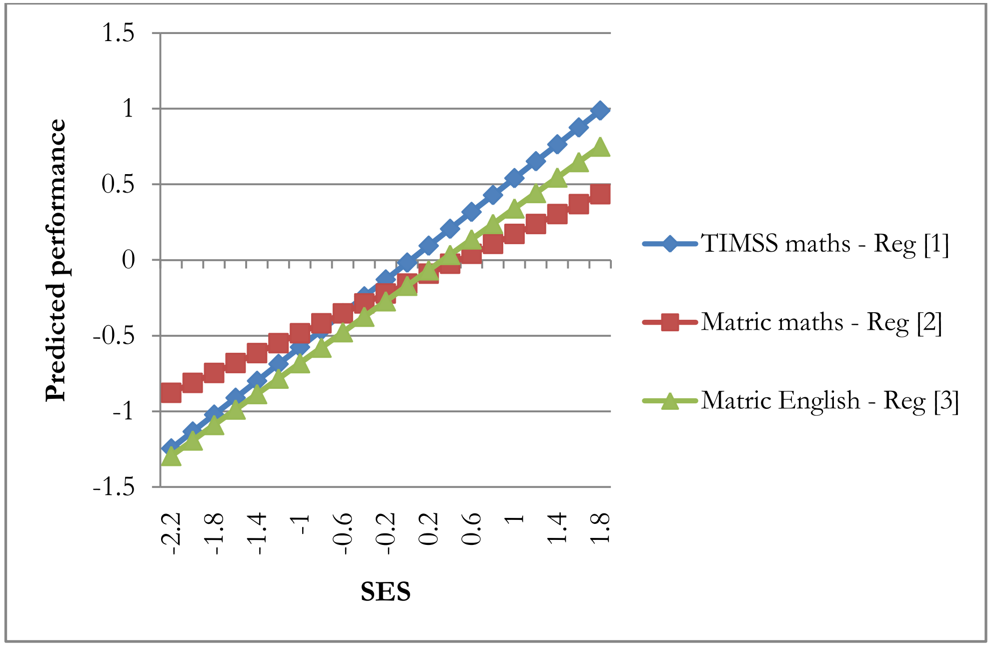
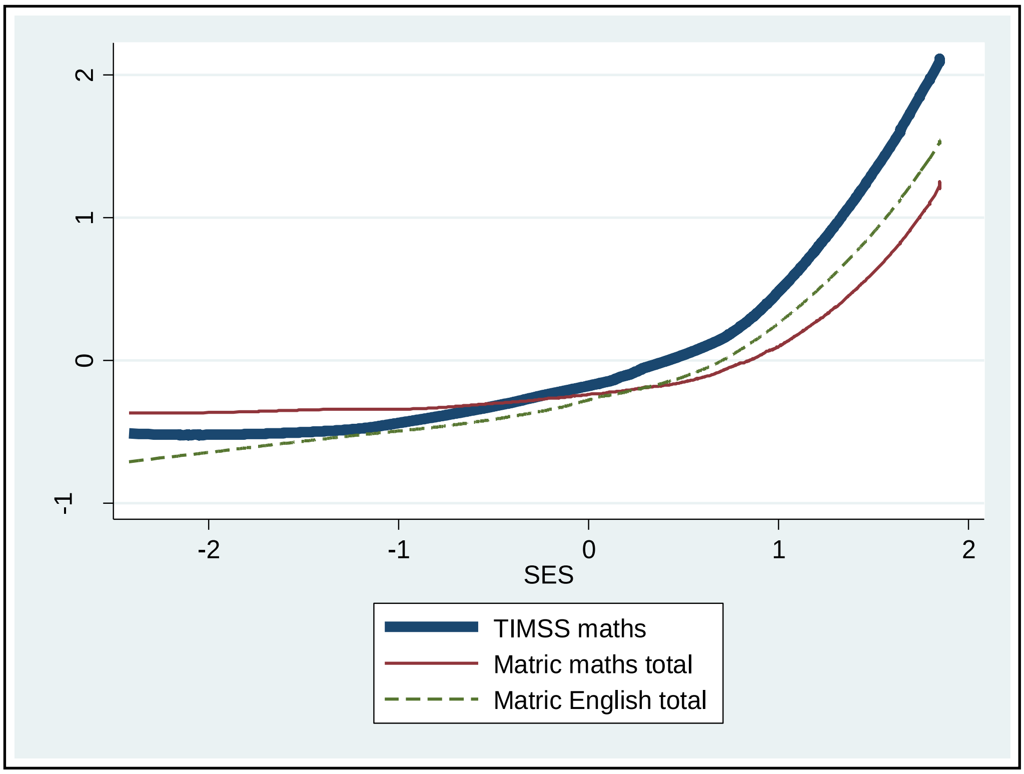


Figure 5.17: Lowess-type gradients for grade 8 achievement and matric achievement

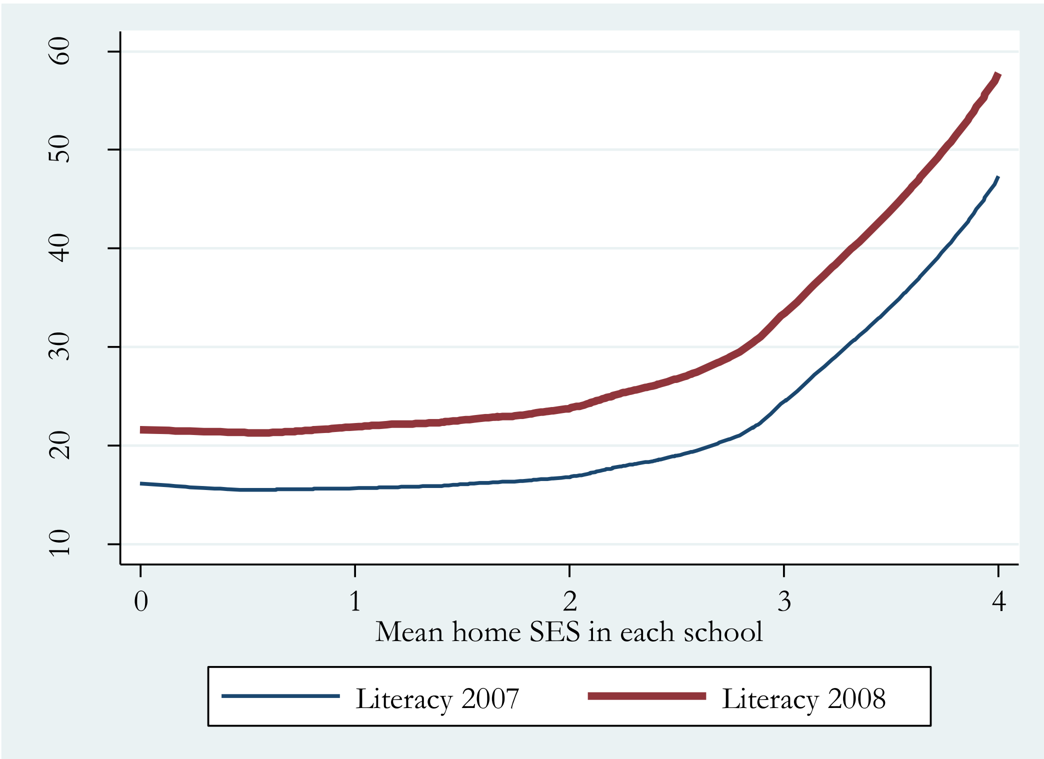


The contention that the most important effects of SES were already laid down by the 8th grade is supported by a comparison of the estimated effects of SES in models [1], [2] and [3] with those in models [5] and [7]. The first three models indicate that SES is a strong predictor of achievement in both grade 8 and matric. Models [4] and [6] show that grade 8 achievement too is a strong predictor of matric achievement. However, when including both SES and grade 8 achievement as predictors of matric achievement, the effect of SES seems relatively unimportant. In model [4] the coefficient on SES is actually small and negative, which would suggest that no important relationship exists. Moreover, the explanatory power of model [5], including both grade 8 achievement and SES, was only marginally greater than that of model [4], which did not include SES. This suggests that the effect of SES was already contained in the distribution of grade 8 achievement, and that little further sorting on the basis of SES occurred in secondary school.

Models [6] and [7] can be similarly interpreted: approximately 61% of the variation in matric English achievement was explained by TIMSS mathematics scores, while including SES increased the proportion of variance explained to about 62%, a small addition. Therefore, the combination of regression models in Table 5.11 indicates that the effect of SES on educational achievement was already established by grade 8. This result could perhaps be interpreted in an optimistic vein: at least achievement gaps do not appear to further widen between grade 8 and matric. On the other hand, with such large disparities already evident at grade 8 it can be concluded that interventions at the secondary school level are too late. Earlier interventions are required to prevent such a substantial learning deficit amongst low SES students at the start of high school.

A comparison of lowess-type socio-economic gradients at the 3rd and 4th grade is possible using the NSES data. Figure 5.18 shows these for literacy.[78] The figure demonstrates that the same basic pattern of achievement by SES is already evident in early primary school. Also, the pattern remained effectively the same from grade 3 to grade 4. Only the level of achievement was slightly higher in grade 4, reflecting one additional year of learning. The average gain in literacy achievement from grade 3 to grade 4 was just less than 8 percentage points and this was fairly similar across the socio-economic distribution, as is visible in the figure. Thinking of 8 percentage points as a crude estimate of a year's learning, it can be seen that low SES students suffered a deficit of approximately 3 years worth of learning relative to high SES students.

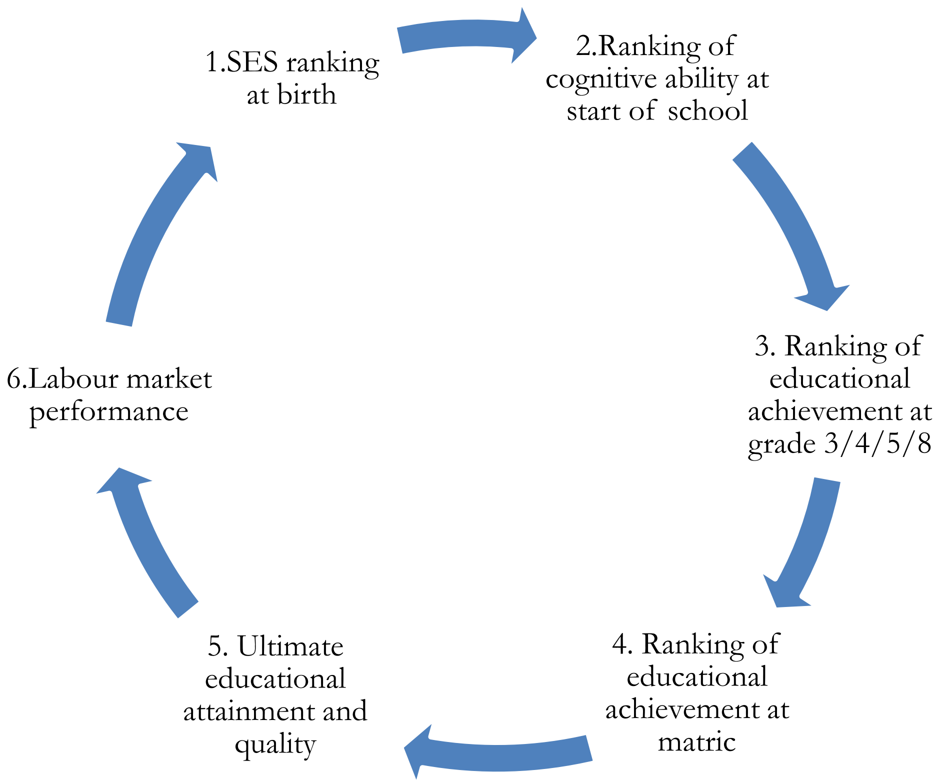
Figure 5.18: Lowess-type gradients for literacy in grade 3 and grade 4 (NSES)



[78] Similar lowess-type gradients were produced for numeracy in grades 3 and 4, but are not reported here. The pattern was very much the same as for literacy.

This thesis has presented various snapshots of the distribution of educational achievement at different stages in the school trajectory. It is clear that achievement is very unequally distributed on the basis of SES and that this pattern is established very early on in the course of schooling. This has important implications for social mobility, conceived of as the ability of low SES members of society to move up the distribution. A schematic diagram was used in Chapter 1 to provide a framework for thinking about the role of education in the social mobility process. This is reproduced below. The datasets considered in this thesis have demonstrated that any snapshot of the distribution of educational achievement during school (point 3 in the diagram) has a strong socio-economic dimension. This chapter has shown that performance in matric (point 4) is strongly determined by achievement in grade 8. The effect of SES (point 1) on matric achievement is predominantly indirect through the earlier effects that are already evident in primary school (point 3). This means that early interventions to reduce the negative effects of poverty on cognitive development are perhaps likely to be the most effective way to reduce overall educational inequalities.

Figure 5.19: Schematic diagram of the social mobility process



Another way to consider the extent to which mobility is possible is to assess the number of students from poor backgrounds that do ultimately achieve educational results that stand them in good stead on the labour market. Figure 5.20 shows the proportion of students in the poorest and richest quintiles in the TIMSS sample that went on to pass matric, score above 50% in matric English and score above 50% in matric mathematics. Approximately 28% of the poorest quintile reached matric and passed in either 2006 or 2007, whereas approximately 58% of the richest quintile achieved this. Slightly less than 8% of the poorest quintile reached matric and scored above 50% for matric English, while only about 3% achieved more than 50% in matric mathematics. This indicates that very few students from poor backgrounds ultimately realise the level of educational outcomes that are necessary to give them a meaningful opportunity to escape poverty. Thinking in terms of the schematic diagram in Figure 5.19, this result provides an indication of the prospects for mobility between point 1 and point 4.

Figure 5.20: Proportions of poorest and richest SES quintiles in grade 8 achieving various matric performance thresholds

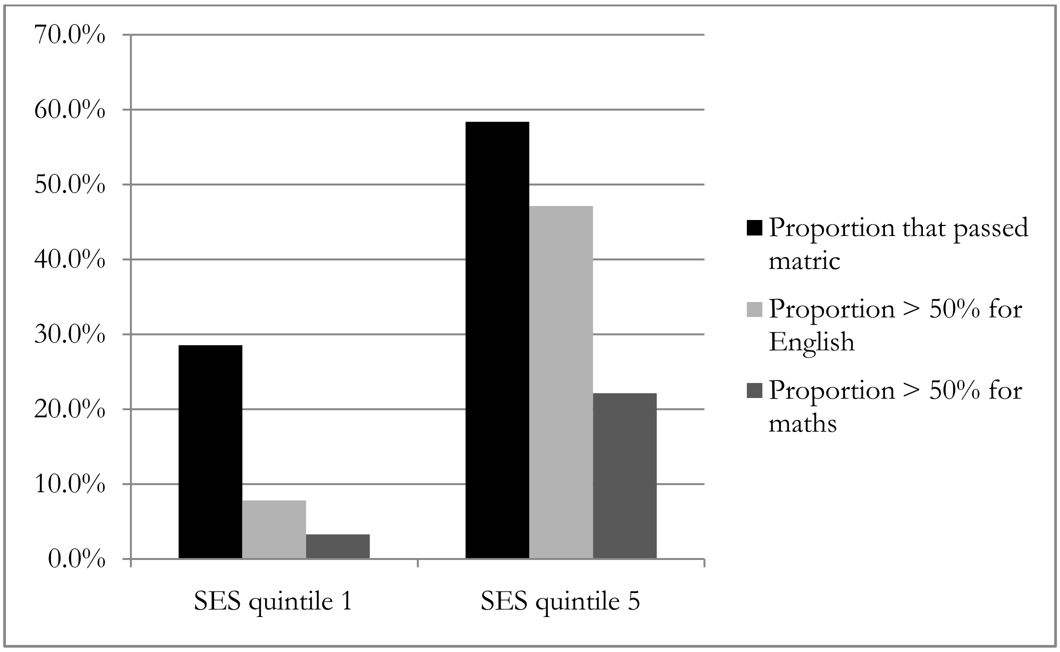
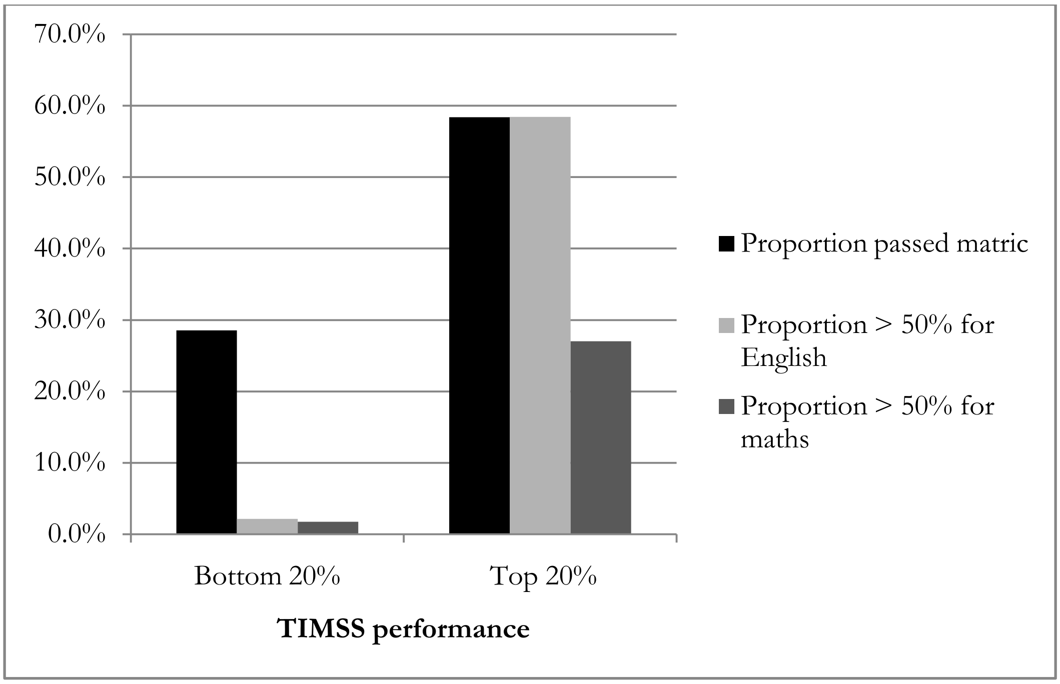


Figure 5.21 presents the same statistics but for the top and bottom quintiles of performers in TIMSS. Although just less than 30% of the bottom performers in TIMSS ultimately passed matric, a very small proportion of this group achieved relatively high marks in matric English and mathematics. Slightly over 2% achieved more than 50% in English and just less than 2% achieved 50% or more for mathematics. This indicates that low achievers in grade 8 are highly

unlikely to ultimately realise high levels of achievement in matric. In terms of Figure 5.19, this suggests that very little mobility occurs between point 3 and point 4.

Figure 5.21: Proportions of top and bottom performance quintiles in grade 8 achieving various matric performance thresholds



The PIRLS dataset offers some perspective about the prospects for mobility according to these indicators in South Africa compared with other countries. Figure 5.22 depicts the proportion of students scoring above the national average reading score in South Africa, Morocco, Russia and the USA by SES quintile[79]. Note that the average reading scores are 302 for South Africa, 323 for Morocco, 540 for the USA and 565 for Russia. For quintiles 1-4, South Africa had the lowest proportion scoring above the national average.[80] In South Africa, only approximately 22% of students within the bottom SES quintile managed to score above the national average (302). This is very different from Morocco (a country with a comparably low level of reading achievement and significantly lower GDP *per capita* than South Africa) where 34% of students within the bottom SES quintile scored above the national average (323). It is striking that in Russia, where the national average was as high as 565, approximately 42% of students within the bottom SES quintile scored above it.

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[79] As in Chapter 3, the SES index for each country was derived using PCA on the various "possessions" questions administered in PIRLS.

[80] Note that only about 40% of the entire South African sample scored above the national average, a result of the skewed distribution of reading scores in South Africa with a small group of high performing schools raising the mean score.

Figure 5.22: Proportions scoring above the national average in PIRLS by SES quintiles

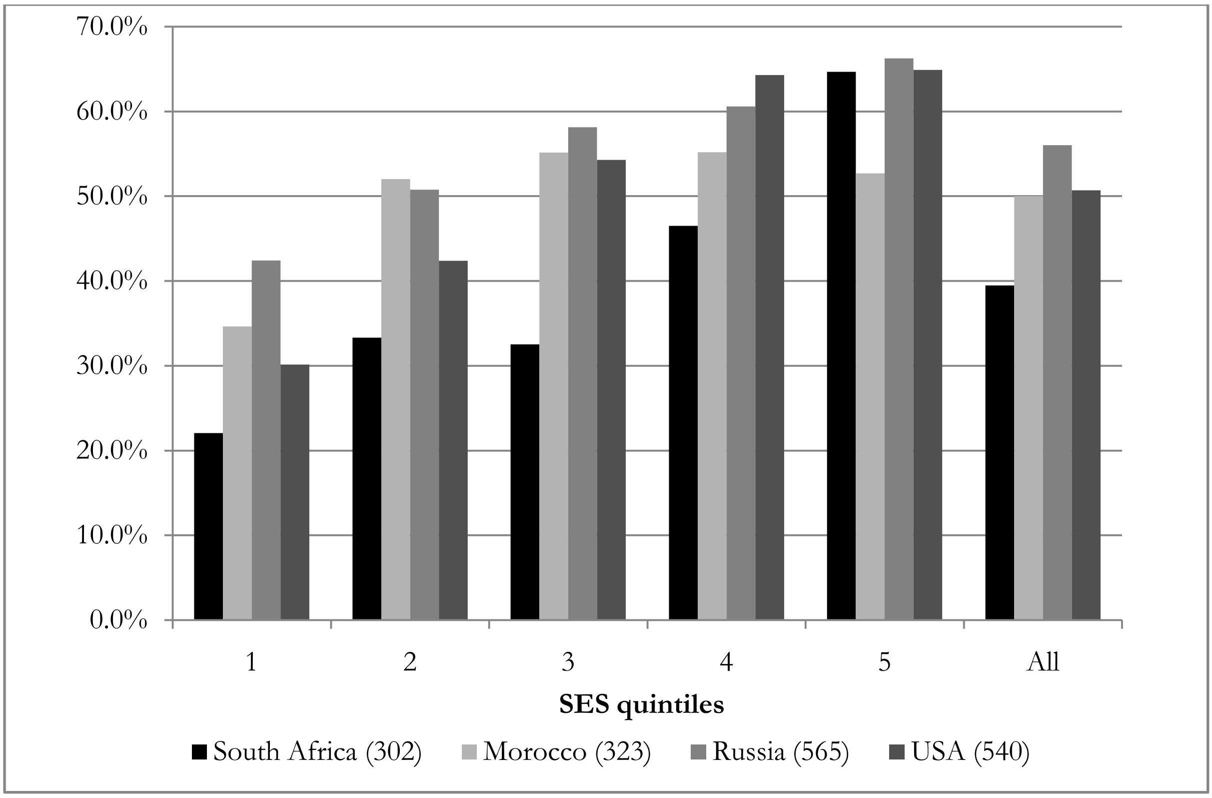
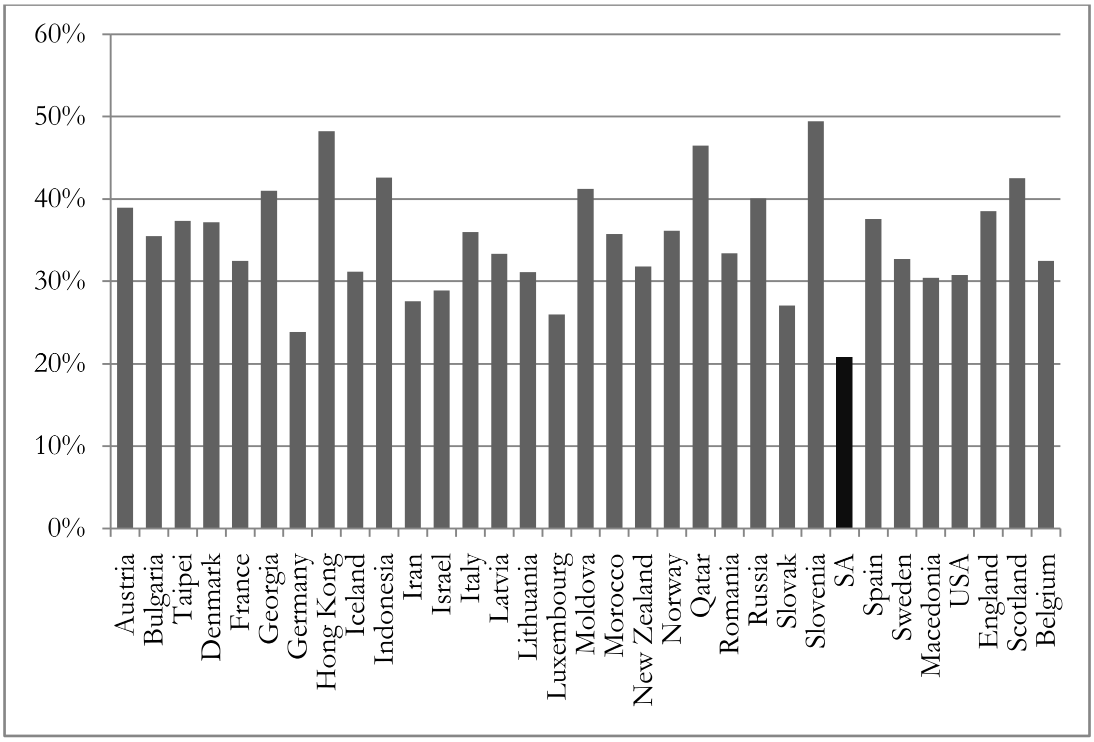


Figure 5.23 shows the proportion of quintile 1 students scoring above their national average for all the countries in PIRLS.[81] In most countries between 30% and 40% of the poorest quintile scored above the national average. The figure confirms that South Africa had the lowest proportion scoring above the national average. This implies that in South Africa, poor students have the least chance of performing well relative to other children in their country.

[81] Several participants in PIRLS were not included in Figure 5.23 due to insufficient information required to derive the index for SES in these countries.

Figure 5.23: Proportions of poorest quintile scoring above the national average in PIRLS



Bearing in mind that it has been shown that achievement in grade 8 strongly predicts matric achievement and that there is little mobility in achievement between these two points, Figures 5.22 and 5.23 can be taken as an indication that the school system in South Africa is contributing very little to social mobility by international comparison. Considerable educational deficits are already evident by grade 5 and clearly persist through to grade 8 and matric. If increased social mobility is to be achieved, interventions prior to high school will be necessary – at the primary school level and perhaps even at the level of Early Childhood Development (ECD).

5.4) An application of the Principal-Agent Model to South African schooling and to weak assessment practice therein

Unreliable and lenient assessment practices, which have been shown to be widespread in South African schools, represent a breakdown of information or of feedback in the system. There is imperfect feedback to children about their progress (hindering effective subject choice and exam preparation), to parents about the progress of their children and the quality of schooling being received, and to the Department of Education about the effectiveness of schools and their management teams. This lack of information weakens the accountability of school management to these other stakeholders in the education process.

In agency theory and incentives theory, the Principal-Agent (P-A) model formally describes a particular type of relationship characterised by this sort of breakdown in transparency. According to this model, the Principal contracts an Agent to manage a certain business or initiative, the goals of which are determined by the Principal. The aim of the P-A contract is to maximise the utilities of the Principal and the Agent. Formally, the Principal's utility may be expressed by the following function:

$$U_P = u(\uparrow \pi, \downarrow W, R, M_c) \qquad (5.1)$$

In Equation (5.1) U_P is the utility of the Principal, π refers to the goals of the Principal (in most private sector organisations π is profit maximisation, although in education it could be educational outcomes), W is the wage paid to the Agent, M_c is the cost associated with monitoring the Agent's behaviour and R refers to any other factors that may influence the Principal's utility, such as the specific market conditions prevailing. The Principal's utility is constrained by a minimum W such that the Agent will agree to the contract. Thus U_P is positively related to π and inversely related to W. Monitoring affects U_P negatively due to the cost associated with it, although it affects U_P positively via its ability to increase effort on the part of the Agent, which in turn improves the achievement of π.

The Agent's utility on the other hand can be given by the following function:

$$U_A = u(\uparrow W, \downarrow Eff, \uparrow L, X) \qquad (5.2)$$

In this case U_A is the utility of the Agent, W is the Agent's wage as before, Eff refers to the amount of effort on the part of the Agent, L is the amount of leisure time the Agent enjoys and X captures the goals of the Agent other than minimising Eff and maximising W and L. The Agent's goals (X) may overlap with or include the Principal's goals (π). A typical example of X that may compete with the goal of the Principal is when the Agent seeks to increase production beyond the profit-maximising point because of the status of managing a big company.

As soon as the goals of the Principal and the Agent differ ($\pi \neq X$), a P-A problem exists. The problem is compounded when a degree of asymmetric information exists, usually such that the

Agent has better access to information than the Principal. The Agent may even deliberately hide information from the Principal so as to shirk or pursue alternative objectives (the problem of moral hazard). The Principal now has various options to try to ensure that his goals are achieved. He may decide to monitor the activities of the Agent, but this comes at a cost, M_c. Or he can build incentives into the Agent's contract such that she also benefits from achieving his goals, π. For example, the Agent's salary can be tied to the profit of the firm – a form of performance pay. A third possibility, only feasible in some cases, involves reaching a situation where they have the same goals ($\pi = X$), the position that Besley and Ghatak (2005) promote. This can be achieved by contracting an Agent with the same motivations and goals as the Principal or by deciding on the goals in collaboration. If such a scenario is possible, the costs of monitoring and enforcing an incentive scheme can be avoided.

As De Villiers (1999) has observed, the P-A model is an apt description of some of the relationships in education systems. In the South African context the P-A problem in education is particularly complex. From one perspective the Principal in education is the government or the minister of education and the Agent is the school management team (school principal and staff). Yet, from the point of view of each individual school, the Principal can be seen as the School Governing Body (SGB), representing all the stakeholders in a school. Indeed, the South African Schools Act (1996: 8) stipulates that SGB's are juristic persons and vests the governance of schools in their SGB.[82] There is also confusion regarding what the goals of the Principal are (De Villiers, 1999: 392). For example, there is evidence to suggest that many school management teams have not properly understood the requirements of the curriculum. Even when the school staff does understand the goals of the education department they may also have competing goals, i.e. the goals differ.

In this situation two main problems hinder the achievement of the Principal's goals, whether the Principal is seen as the Department of Education or the parents and SGB. Firstly, there is a problem of *asymmetric information* regarding the effort and effectiveness of teaching and school management. In the absence of meaningful assessment feedback prior to the matric examination, parents and government have little way of gauging school effectiveness. This is especially true at the primary school level. Secondly, teachers face a perverse *incentive structure*, often resulting in shirking behaviour in the form of absenteeism, poor planning, low effort in preparing classes, etc. This incentive structure arises because outstanding teacher effort and

[82] As opposed to the function of professional management, which is vested in the school principal and staff.

instructional leadership that lead to exceptional student outcomes are rarely rewarded, while low teacher effort and inefficient management resulting in poor student achievement are rarely penalised. It is likely that these problematic P-A dynamics contribute to the unacceptable outcomes produced by the bulk of the school system.

Several alternatives exist by which one might attempt to resolve this P-A problem in South African schooling. Firstly, one could impose a system of monitoring and administrative requirements in order to ensure that various aspects of best practice are implemented in all schools. For example, several of the management variables that were shown to be significantly associated with student achievement in Chapter 4 may be regarded as best practice. Therefore, through monitoring one could ensure that curriculum planning is done using a year schedule, that LTSM inventories are up to date and that certain numbers of complex mathematics exercises can be found in student workbooks at particular times in the year. A major problem with this strategy is that it would impose a huge administrative burden on monitors and teachers alike. Moreover, these aspects of best practice are merely indicators of the broader feature of good management. Therefore, such a strategy may in fact empty these practices of their value and not bring about the intended improvement in student achievement.

Having said this, there is some evidence from the small literature on experimental design interventions into South African schools that there are certain pedagogical practices that can produce improvements in student achievement when thoroughly applied and monitored. Schollar (2001) reviews the impact of the READ programme that was experimentally applied in two poor regions of the Eastern Cape. The programme targeted 35 schools in the Transkei region and 37 schools in the Ciskei region and involved whole-school teacher training, book provision and frequent monitoring. Students were tested before and after the intervention in reading and writing. The results showed a strong and statistically significant impact of the programme in both regions relative to the control groups. The implications of this result for policy are not straightforward, however. It would be costly and difficult to implement the kind of monitoring that accompanied the READ programme. Moreover, such monitoring is unlikely to be palatable to many teachers and may therefore be opposed by the teacher unions.

A second strategy is to change the incentives facing teachers and school principals by implementing some form of performance pay. Here again, opposition from teacher unions, who have historically been opposed to differential teacher pay, is an obstacle. Moreover, it is particularly difficult to accurately and fairly assess teacher performance. Teacher effort or commitment is impossible to observe. Relying on peer reviews is fraught with incentives to cheat the system. Taking student achievement as a proxy for teacher performance is therefore an obvious option. However, there are numerous factors impacting on student achievement other than the teacher. Therefore, one might look to improvement in student achievement as a measure of teacher performance. It is, however, difficult for top-performing classes to keep improving. Another danger inherent to such a scheme is that it may promote "teaching to the test" at the expense of other worthy educational outcomes. All this is not to write off any consideration of somehow linking teacher pay to performance. However, it is clear that any such policy will need to be very carefully thought out and may have to overcome significant political opposition.

Thirdly, the capacity of SGBs could be built up and through this institution, parents could be encouraged to participate more closely in school processes and the monitoring thereof. In effect this would bring the Principal in the model "closer to the action" thus increasing the school's accountability to stakeholders. An interesting literature dealing with various monitoring experiments conducted in developing countries with the aim of reducing teacher absenteeism points to the value of using parents as monitors of school processes.[83] Through scholarships or other rewards for high student achievement, these experiments have typically managed to increase the concern of parents with the performance of their children. This has in turn produced greater accountability of teachers to parents, resulting in lower teacher absenteeism. The important lesson from these experiments is that monitoring schemes are most successful when parents become directly involved and thus put pressure on teachers to attend school regularly. Monitors should preferably stand to gain personally from improved school quality. Similarly, the literature on the monitoring of corruption suggests that monitoring is most effective when those who personally stand to gain from reducing corruption do the monitoring (Olken, 2005).

Fourthly, recognising that the "key Agent" is the school principal, interventions could aim to ensure that the most effective and committed leaders occupy principal positions. It is widely accepted that the best teachers and principals are those who are intrinsically motivated to teach children and build school communities. If highly effective and motivated individuals could be tasked with leading schools that have been operating at a low level of functionality, this would create a situation where the goals of the Agent and the Principal would largely overlap.

[83] For example Banerjee and Duflo (2005), Chaudhury *et al* (2004) and Muralidharan (2006).

A final strategy for addressing the P-A problem is simply to improve the availability and comparability of student assessment information. This could be done through nationally standardised evaluations prior to matric. This should preferably be done for one or two grades in primary school and in grade 9. The results should then be easily available to parents at the individual level (so parents and students know how they are progressing) and at the school level (so that the performance of the various schools in the area is comparable). This would serve to reduce the problem of asymmetric information, foster greater parent involvement in schools and strengthen accountability.

The last three strategies discussed above are considered in more detail in Chapter 7 where several policy suggestions are made. It is important to note that when using the P-A model as a framework for analysing South African schooling these policy strategies follow logically from the model.

5.5) Chapter summary

Apart from the well known disparities in the overall level of performance between the historically different parts of the school system, this chapter has also highlighted interesting differences in the ability of these groups of schools to convert given levels of achievement in grade 8 into performance outcomes at the matric level. An initially surprising, and yet very consistent pattern, was that students at given levels of grade 8 achievement performed better in matric if they were in historically black schools than if they were in historically coloured schools. To some extent this may be a reflection of under-utilisation of the human capital that historically coloured schools demonstrated in grade 8, or conversely, of the success of educational interventions within historically black high schools. A preferred explanation is that factors such as writing TIMSS in a language other than home language, exposure to inaccurate assessment and poor exam writing technique may have contributed to a systematic underestimation of the capabilities of students in historically black schools in TIMSS. If this was the case, these students may have been able to perform at a level nearer to their true ability in matric, thus creating the impression of greater improvement since grade 8.

Patterns in taking mathematics in matric were also consistent with the hypothesis of weak assessment in historically black schools. In these schools, there was very little difference in the average performance in TIMSS between students who took mathematics in matric and those who did not. The very low level of mathematics performance in both TIMSS and matric of these students would suggest that they had a rather inflated idea of their mathematics knowledge. Inaccurate and lenient assessment would have contributed to such an inflated idea. This suggestive evidence complements other recent research that has highlighted weak assessment practices in parts of South Africa's school system. Assessment practice has thus emerged as a prominent and significant aspect of school quality in this chapter, despite the fact that an investigation of this issue was not explicitly intended when the analysis was embarked upon.

CHAPTER 6: A COMPARATIVE ANALYSIS OF THE EFFECTIVENESS AND EFFICIENCY OF THE PUBLIC AND INDEPENDENT SCHOOLS SECTORS IN SOUTH AFRICA[84]

6.1) Motivation for an investigation into the independent schools sector and chapter overview

"Formal schooling is today paid for and almost entirely administered by government bodies or non-profit institutions. This situation has developed gradually and is now taken so much for granted that little explicit attention is any longer directed to the reasons for the special treatment of schooling even in countries that are predominantly free enterprise in organization and philosophy."

(Milton Friedman, 1962, quoted in Curren, 2007: 194)

One of the central debates in economics concerns the appropriate roles of the market and of regulation to govern various spheres of economic life. Mainstream neoclassical economics emphasises the ability of the market mechanism to deliver high levels of efficiency due to the incentives to perform that face individuals. This has influenced thinking around education too, and the question of whether the private sector is better at producing high quality education than the public sector is one of the major themes in the economics of education literature.

It is worth investigating the ability of the private sector to contribute to building human capital in South Africa. This thesis has demonstrated that SES strongly influences educational achievement in South Africa. Moreover, it has been shown that outcomes in low SES schools are less responsive to inputs and normally beneficial school and teacher characteristics than is the case in more affluent schools. It is therefore particularly relevant to explore whether the private sector can produce better quality education in poor contexts, where the majority of the existing system is operating at a very low level. Knowledge about the effectiveness and efficiency of the independent sector relative to public schools may signify an important potential role for independent schooling in South Africa's economic development, as conceived of in this thesis. The demographic composition of independent schools is of interest in order to assess who is benefiting, or could benefit, from any systematic advantages that independent schools may offer. Knowledge about what is driving any such performance advantages may also be useful beyond

[84] This chapter is based on a report undertaken by the author for the DoE in September 2009. The author is therefore grateful to the DoE for permission to reproduce this work and to Martin Gustafsson for guidance during the compilation of the initial report.

merely the public-private debate, in so far as it sheds light on aspects of school quality that might be more broadly applicable than just in the independent sector.

The datasets analysed thus far in this dissertation have not allowed for a sector-specific analysis. The relative performance of public and independent schools in South Africa is a largely un-researched area. Traditionally, the independent schools sector in South Africa has been perceived to be "white, affluent and exclusive" (Hofmeyr and Lee, 2004: 143). An associated perception is that independent schools offer a higher quality of schooling than public schools. This chapter interrogates these perceptions and shows them to be either incorrect or too simplistic. The first section provides a review of international research on the relative effectiveness of independent schooling. Thereafter, the chapter analyses the relative performance of the independent school sector, beginning at a fairly descriptive level and culminating with some multivariate regression analysis. Data was drawn from several sources for these purposes. These include the SACMEQ II dataset, the 2007 Community Survey by Statistics South Africa, the Annual Survey of Schools by the DoE and the Senior Certificate database.

6.2) International evidence on the relative effectiveness of private schools

More than half a century ago, Milton Friedman (1955) proposed that vouchers be given to parents so that they would be able to enrol their children in private schools instead of public schools. This proposal, which has been implemented in various contexts, notably in parts of Latin America, is premised on the view that private schools are more effective at producing student achievement than public schools. A vast literature interrogating this assumption has subsequently burgeoned. Much of this literature has focused on developed countries, although more recently a considerable amount of research has been documented examining the relative effectiveness of private schools in developing countries. The relative effectiveness of private schools, or the "private school effect", can be understood as the performance advantage of private schools over public schools holding SES and other home background characteristics constant. Private schools are also often touted as being more efficient than public schools, i.e. that they are able to produce the same level of student outcomes at a lower cost.

There are several theoretical reasons to expect private schools to be relatively more effective at producing student outcomes than public schools, and why they may be expected to do so at lower costs. Kingdon (1996: 58) discusses three such reasons. Firstly, the accountability of schools to parents is usually stronger in private schools due to the fees that are charged, and this accountability translates into harder work to satisfy parental expectations regarding the quality of instruction. A related reason is that competition amongst private providers of education can be expected to produce higher quality. Thirdly, it is often held that the decentralised management structures, which characterise private schools, are more conducive to efficiency. Conversely, the management structures that are often characteristic of government schools can produce low efficiency and staff motivation.

This section reviews the developing country literature on the relative effectiveness of private schooling. Most of these studies are based on the Latin American context, largely because the extensive voucher programmes implemented in these countries have provided data appropriate for estimating the so-called "private school effect". A comprehensive and revealing study was done by Kingdon (1996) on the relative effectiveness of private schools in India. This provides an insight into private schooling in the developing world outside of Latin America. However, there is a lack of research comparing private schools and public schools in the contexts of Africa and South Africa. The research in this chapter is therefore located in fairly uncharted territory. The findings should be regarded as suggestive rather than definitive, due to data limitations, as will be discussed in the next section.

6.2.1) Research from Latin America and India

A number of studies on the relative effectiveness of private schools have drawn on the Chilean case. Chile is unique because it has had a universal voucher system in place since the early 1980's. Under this system, all children of a school-going age have the opportunity to attend public schools or private schools. The government then subsidises both sectors of schools with vouchers on a per-student basis. Private schools have the option of charging fees, although this means that schools forgo a proportion of the voucher depending on the level of fees charged. The result is that schools in Chile can be grouped into four categories, as Anand, Mizala and Repetto (2009: 372) describe. Non-voucher fee charging private schools are completely financed by fees and receive no subsidy. Fee-charging private voucher schools are financed by a combination of fees and vouchers received from government. Free private voucher schools are completely financed by government vouchers although they are privately owned and managed. Finally, public schools are financed, owned and managed by the municipal authorities. Some studies also distinguish between religious and non-religious private schools (e.g. McEwan and

Carnoy, 2000). Since the reforms of the 1980's the private schools sector has expanded considerably. In 2002, non-voucher fee charging private schools accounted for about 8.5% of Chilean students, fee-charging private voucher schools accounted for about 25.3% of students, free private voucher schools accounted for about 12.5% of students and public schools served approximately 52.1% of students (Anand *et al*, 2009: 372).

McEwan and Carnoy (2000) found that non-religious private voucher schools were no more effective at producing student achievement than public schools, after controlling for the socio-economic profile of the student body and other school characteristics. However, non-religious private schools were found to have a cost-effectiveness advantage over public schools of about 13-17%. McEwan and Carnoy (2000: 227) suggest that the combination of higher wages and less regulatory flexibility within the public schools sector may underlie this difference in cost-effectiveness. A study published by the Central Bank of Chile (Ramos, 2002) concluded that private schools could not be said to be uniformly more or less effective than public schools. The study did, however, find that public schools were more effective for low SES students (Ramos, 2002: 31).

A weakness of the studies by McEwan and Carnoy (2000) and Ramos (2002) is that the data used by them did not have student characteristics, but only school-level variables. This means that various important student characteristics could not be included as explanatory variables, and that any bias in the way students selected themselves into public and private schools could not be controlled for either. More recently, student-level data for Chile has become available, thus allowing analysts to improve estimates of the private school effect. Anand *et al* (2009) compared the relative effectiveness of fee-charging private voucher schools, free private voucher schools and public schools applying corrective measures to control for sample selection and including SES and various other student characteristics. A noteworthy innovation of this study was that it identified students in fee-charging private voucher schools who were awarded scholarships (not based on academic achievement) and would otherwise have attended free private or public schools, and then compared their performance with students of matching characteristics in the other school types. Anand *et al* (2009; 371) conclude that both free and fee-charging private schools were more effective at producing academic achievement for low SES students than public schools. The estimated effect was statistically significant, although fairly small. However, the authors warn that their methodology did not allow for certainty as to why students with the same characteristics did better in private schools. The effect could have been due to academically stronger peers in private schools, more involved parent bodies, superior school management or more effective teachers, but it was not possible to examine any of these possible channels explicitly (Anand *et al*, 2009: 371).

Another extensive voucher programme has been implemented in Columbia. The "Programa de Ampliación de Cobertura de la Educación Secundaria" (PACES) has provided vouchers amounting to the equivalent of low to middle fee-charging private schools in Columbia. These vouchers could be used within fee-charging public schools or private schools and were renewable conditional upon passing each grade. The value of the voucher was received by the schools directly from government. An interesting feature of the Columbian case is that many vouchers were distributed by a lottery due to excess demand. This created a type of natural experiment suitable for an analysis of the benefits of receiving a voucher: the outcomes of lottery winners could be compared with those of lottery losers with otherwise similar characteristics. To the extent that the vouchers increase the probability of enrolling in a private school the analysis of the benefits to receiving a voucher through the lottery also has implications for the relative effectiveness of private and public schools in Columbia.

In this way, Angrist *et al* (2002) examined the benefits to lottery winners in Columbia three years after the vouchers were awarded. Lottery winners were found to be approximately 10% more likely to have completed the 8th grade than lottery losers, mainly because of reduced grade repetition. Moreover, lottery winners achieved higher test scores and were found to be less likely to cohabit as teenagers or to be employed – conditions considered unfavourable to educational outcomes. Furthermore, Angrist *et al* (2002: 1556) estimated that the expected future economic benefits in terms of wage returns to lottery winners far exceeded the economic cost of the vouchers. The authors attributed the benefits of the PACES vouchers to three possible channels. Firstly, lottery winners were more likely to attend private schools than were lottery losers, and private schools may have been more effective than public schools. This is suggestive of a positive private school effect on the educational outcomes observed. Secondly, voucher recipients who would have attended private schools anyway, may have attended more expensive schools, which were also better schools. Thirdly, the fact that vouchers could be lost through failure to progress to the next grade may have incentivised students to work harder, leading to the observed benefits (Angrist *et al*, 2002: 1556).

An earlier and influential study by Cox and Jimenez (1991) examined the private school effect in Columbia prior to the introduction of the PACES vouchers, as well as in Tanzania. They presented evidence of a private school achievement advantage in both Colombia and Tanzania after controlling for student and school characteristics. However, this study has come under some negative critique for omitted variable bias regarding school characteristics (Glewwe, 2002: 461), and for not adjusting for peer effects or clustering (Somers, McEwan, and Willms, 2004: 55).

Somers *et al* (2004) have demonstrated how adjusting for peer effects can substantively alter the estimated relative effectiveness of private schools. Their analysis covered ten Latin American countries and estimated the private school effect using three different statistical models, and applying them to each country. In the first model the educational outcome of interest (language achievement or mathematics achievement) was predicted solely by school type and grade. This model specification yielded estimates of a private school achievement advantage in the region of half a standard deviation. The second model specification included controls for student SES and school location. This specification obtained slightly smaller estimates of the private school effect, indicating that a small proportion of the achievement advantage enjoyed by private schools was attributable to the higher SES of students in those schools. The third model included peer group characteristics and returned estimates of the private school effect that hovered around zero. The authors therefore conclude that a large proportion of the superior performance of private schools was accounted for by peer effects (Somers *et al*, 2004: 69). This is perhaps an irrelevant point from the perspective of parents deciding on whether to enrol their children in private or public schools. However, it holds important implications from a policy perspective: if the private school effect emanates from peer group characteristics rather than more effective management and governance, then increasing the size of the private school sector may not necessarily improve outcomes substantially because "the stock of good peers is finite", as Somers *et al* (2004) argue.

Geeta Kingdon (1996) carried out a very thorough analysis of the private school effect in the case of Indian students in their final year of primary school. Her study was dealt with favourably by Paul Glewwe (2002) in his extensive and scrutinising review of the literature on schooling in developing countries. Kingdon's study focussed on three categories of schools in India – government schools, privately managed schools that are almost entirely funded by government (private aided schools) and private unaided schools. Kingdon (1996: 61) suggests two *a priori* reasons to expect private schooling in India to be of a higher quality than publicly funded schools. The higher level of performance on examinations by private schools was a first indicator of quality. Secondly, the observable growth in the demand for fee-charging private unaided schooling was probably reflective of the higher quality of education offered by that sector of the school system. Making appropriate adjustments to control for sample selection into the three school types, Kingdon (1996) found that unaided private schools had a performance advantage over aided private and government schools, after controlling for student characteristics. Kingdon also collected data on the cost per pupil in each of the schools in the study. Using this information, she established that unaided private schools were also more cost-effective than the other school types, thus reinforcing their achievement advantage. She therefore advocates the expansion of the private unaided school sector, arguing that this would promote an efficiency gain as well as improvement in equity because the public funding for government schools would then be better targeted toward the poor (Kingdon, 1996: 78-79).

6.2.2) Evidence from Africa

The literature on independent schools in Africa, specifically on the relative effectiveness of private schools in comparison with their public sector counterparts, is thin. Bernstein (2005) reviewed several international research projects which point to the potential benefits of private education for poor children in Africa and Southern Africa (Bernstein, 2005). According to one of the studies reviewed in Bernstein (2005), private schools serving the poor in Ghana, Nigeria, Kenya, India and China were able to produce higher student achievement at lower cost. Although the Bernstein (1995) report is a rather broad-brush meta-analysis, it does at least offer some indication that private schooling may be a promising alternative in Africa.

In order to gain some further indication of the performance of independent schools in Africa, some brief analysis was done using SACMEQ II data. This dataset contains reading and mathematics test scores for grade 6 students in 14 Southern and East African countries, together with information about the schools, teachers and home backgrounds of these students. The data are therefore suitable for multivariate regression analysis, although not ideal for analysing the relative effectiveness of independent schools due to the small number of independent schools that were surveyed. Table 6.1 shows the number of public and independent schools that were surveyed in the SACMEQ II project, for each country. The table also reports the average mathematics and reading achievement for each country. Note that the scores are scale average scores, which were set to have an international mean of 500 and a standard deviation of 100.

Table 6.1: Numbers of Public and independent schools in the SACMEQ II sample

	Public	Independent	Total	Mean Mathematics	Mean reading
Botswana	164	6	170	513	521
Kenya	176	8	184	563	546
Lesotho	70	107	177	447	451
Malawi	137	3	140	433	429
Mauritius	118	35	153	585	536
Mozambique	162	6	168	530	517
Namibia	258	12	270	431	449
Seychelles	23	1	24	554	582
South Africa	164	3	167	486	492
Swaziland	160	8	168	517	530
Tanzania	181	0	181	522	546
Uganda	154	9	163	506	482
Zambia	164	5	169	435	440
Zanzibar	142	3	145	478	478
Total	2073	206	2279	500	500

It is evident that in some countries only a handful of independent schools were included in the sample. For this reason, countries in which fewer than five independent schools were surveyed were excluded from the multivariate analysis. Another consideration to bear in mind when analysing the performance of independent schools in SACMEQ is the likelihood that the nature and definition of independent schools differs across the SACMEQ countries. Despite this consideration and the small numbers of independent schools in the sample, it was felt that a multivariate regression analysis might yield a useful initial indication of the relative effectiveness of independent schools in Southern Africa. The results of this analysis are reported in Tables 6.2 and 6.3. Table 6.2 presents separate Ordinary Least Squares (OLS) regression models predicting reading achievement for each country. Table 6.3 shows the same for mathematics achievement.

The explanatory variables included a dummy variable for being male, a dummy for whether the student spoke the language of the test at home sometimes or often as opposed to never and a dummy for school location (rural vs non-rural). An index for student SES was constructed by applying PCA to a set of variables capturing whether certain household goods were present in the student's home.[85]

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[85] There were 14 "possessions" variables in SACMEQ II that were included in the SES index. These were a daily newspaper, weekly/monthly magazine, radio, TV set, Video Cassette Recorder (VCR), cassette player, telephone, refrigerator/freezer, car, motorcycle, bicycle, piped water, electricity and a table to write on. Note that this index is based on the author's own calculations and is different from the SES variable provided by SACMEQ with the original dataset, which also reflects parent education.

Table 6.2: Multivariate regressions predicting reading achievement

	Botswana	Kenya	Lesotho	Mauritius	Mozambique	Namibia	Swaziland	Uganda	Zambia
Male	-30.31***	-1.65	-8.47***	-26.51***	8.55***	-6.70***	-9.05***	3.84	5.09
Speaks language	34.23***	25.50***	17.86***	68.65***	43.01***	16.67***	11.21***	37.07***	41.50***
Rural	-15.01***	-18.25***	-17.15***	-7.50	-11.13***	-21.27***	-6.75**	-21.37***	-19.05***
Student SES	13.17***	15.31***	1.24	40.99***	3.72*	5.42***	7.90***	19.22***	4.66
Student SES squared	6.99***	-4.82**	-	-	-	3.85***	-	-	-
School mean SES	0.84	45.73***	32.00***	-53.83***	14.47***	16.32***	-3.51	2.52	24.28***
School SES squared	13.08***	-	29.10***	25.95***	-	24.67***	23.84***	-11.40***	14.21***
Independent	**71.76*** **	**-1.26**	**-9.78*** **	**11.86** **	**9.34**	**12.29* **	**9.21* **	**57.22*** **	**30.89*** **
Constant	504.91***	569.93	461.84***	454.72	482.67***	420.90***	518.47***	483.66***	413.11***
R-squared	0.26	0.21	0.14	0.16	0.08	0.48	0.19	0.11	0.21
Observations	3322	3282	3155	2945	3038	5048	3139	2642	2538
Independent (Reg A)	**163.63*** **	**92.03*** **	**-5.43** **	**11.41* **	**12.42** **	**137.67*** **	**18.52*** **	**72.44*** **	**71.98*** **

Table 6.3: Multivariate regressions predicting mathematics achievement

	Botswana	Kenya	Lesotho	Mauritius	Mozambique	Namibia	Swaziland	Uganda	Zambia
Male	-10.13***	22.69***	-3.12	-7.28	21.95***	3.02	4.80**	15.78***	10.21***
Speaks language	27.19***	15.98***	17.87***	75.54***	33.87***	11.20***	7.94***	20.13***	34.05***
Rural	-7.59**	-13.14***	-25.24***	-12.10**	-6.12**	-15.14***	8.24**	-18.67***	-9.04**
Student SES	11.12***	13.80***	-1.50	20.13**	-1.88	3.90**	6.49***	20.37***	3.00
Student SES squared	-	-5.40*	-	9.77**	-	4.56***	-	-6.32*	-
School mean SES	-0.41	30.71***	11.59***	-52.79***	7.99***	12.73***	-0.11	-9.82***	13.56***
School SES squared	9.08***	6.03**	18.99***	26.43***	-4.99**	22.33***	17.37***	-9.99***	8.64***
Independent	**77.70*** **	**10.14**	**-3.13**	**1.80**	**-0.72**	**19.74*** **	**5.80**	**44.65*** **	**22.13** **
Constant	492.83***	567.61***	450.43***	486.24***	489.73***	400.83***	492.70***	510.61***	403.72***
R-squared	0.16	0.14	0.09	0.16	0.06	0.40	0.09	0.05	0.12
Observations	3321	3279	3144	2870	2999	3990	3138	2619	2517
Independent (Reg A)	**130.52*** **	**84.96*** **	**-3.97**	**1.31**	**1.02**	**128.22*** **	**14.99** **	**52.95*** **	**45.31*** **

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level

For the sake of interpretation, the student SES variable has been standardised to have a mean of zero and a standard deviation of one. The square of student SES was included in the models if its estimated effect was statistically significant, indicating that the relationship between SES and reading or mathematics scores was non-linear. The mean SES for each school was also included in the models, in recognition of the important role of peer effects and the overall socio-economic context of schools. Similarly, the square of school mean SES was included if there was evidence of non-linearity. Lastly, a dummy variable for independent schools was included in order to estimate the so-called "private school effect".

The models in Tables 6.2 and 6.3 predict reading and mathematics achievement using the variables outlined above, for each country. In general, the models predicting reading achievement had greater explanatory power than those predicting mathematics achievement, as indicated by the R-squared values. The models had rather weak explanatory power for some countries, such as Mozambique, while in other countries, such as Namibia, a relatively large proportion of the overall variance in achievement was explained by the models. The effect of gender varied across the models with girls usually doing better in reading and boys usually doing better in mathematics. Speaking the language of the test was consistently associated with higher achievement, while students in rural schools typically performed worse than those in non-rural schools. As might be expected, student SES and especially school mean SES had a strong effect on achievement in most countries.

The coefficients on the independent school dummy can be interpreted as the effect of being in an independent school on a student's score, after controlling for all the other variables in the model. In the case of the reading models (Table 6.2), the coefficients on the independent dummy were positive and statistically significant in six out of the nine countries. In Mauritius, Namibia and Swaziland this effect was fairly small, whereas independent schools had a large performance advantage in Botswana, Uganda and Zambia. The largest effect was for Botswana where being in an independent school was associated with a reading score advantage of 71.76 points, which is almost 0.72 standard deviations on the SACMEQ scale. In Kenya and Mozambique the independent school effect was not significantly different from zero. A small, negative and statistically significant effect was obtained for Lesotho, although the large size of the independent schools sector in this country may be an indication that the public/independent distinction in Lesotho is not directly comparable with that in the other countries. For mathematics achievement, the coefficient on the independent dummy in Table 6.3 was positive and statistically significant in four countries. In the remaining five countries the effect was not significantly different from zero.

The bottom row in each of Tables 6.2 and 6.3 is the coefficient on the independent schools dummy in a reduced version of the model, which for convenience has been labelled Regression [A]. This version of the models predicts reading and mathematics by the independent dummy together with gender and whether the student spoke the language of the test at home. Therefore, school location and SES are not controlled for in Regression [A]. The coefficients on the independent dummy were generally higher in Regression [A], probably a reflection that independent schools are typically more affluent than public schools and that some of the effects of SES and location were therefore contained in the independent dummy. This is indicative of the risks inherent in comparing independent and public schools. The apparent quality premium offered by independent schools is generally only in part attributable to a better schooling process. A large part of this premium is a result of the home background advantages of independent school pupils.

In summary of Tables 6.2 and 6.3, therefore, it appears that there is preliminary evidence of a performance advantage for independent schools in some of the SACMEQ countries. It should be noted that the evidence is not comprehensive across all the countries and is weaker in the case of mathematics achievement. Some of this apparent advantage is due to school location and the SES of students. However, even after taking account of these factors there remains some evidence of a positive private school effect in several of the SACMEQ countries.

6.3) Analysing the performance of the independent schools sector in South Africa

6.3.1) Previous research and the profile of the independent schools sector

Traditionally, there has been a perception that independent schools in South Africa are "white, affluent and exclusive," as Hofmeyr and Lee (2004: 143) observe. Early accounts of the independent schools sector certainly contributed to this perception, and perhaps rightly so. Randall (1982) characterised South African independent schools as "little England in the veld". Similarly, Christie (1990) argued that although private schools in South Africa were open to black students, the dominant ethic at these schools aimed at getting black students to assimilate the dominant white (and specifically capitalist) values.

More recently, using data for the entire independent schools sector collected in 2001 by the Human Sciences Research Council, Du Toit (2004) provided a broad quantitative overview of the sector. This overview confirmed that there has been dramatic growth and change in the profile of the sector. Many new independent schools were registered during the 1990's, with the growth of the sector peaking in 1999 and slowing somewhat thereafter (Du Toit, 2004: 36). Moreover, there have been considerable changes in the socio-economic and racial profiles of independent schools. According to Hofmeyr and Lee (2004: 143), "the majority of students at independent schools are now black, while the majority of schools are new (established since 1990), charge average to low fees and are religious or community-based." Tables 6.4 and 6.5 are based on Du Toit's (2004) sectoral overview and confirm that by 2002 the majority of independent schools charged average to low fees and that the majority of students in independent schools were black. Du Toit (2004: 35) also found that independent schools enjoyed a higher average pass rate in the matric examination than public schools (68.9% versus 61.7%).

Table 6.4: Annual school fees in the Independent School Sector in 2002

School Fee Category	%
R0-6000	52.9
R6001-12000	21.6
R12001-18000	11.7
R18001+	13.8

Source: Du Toit (2004)

Table 6.5: Racial profile of Independent School Sector in 2002

Race group	%
Black	58.3
Coloured	4.8
Indian	7.5
White	29.4

Source: Du Toit (2004)

The Community Survey of 2007 collected a wide range of information about South Africans at the individual and household level, including a question about whether those enrolled in an educational institution were in a public or independent institution. This allows for a more recent estimation of the characteristics of those in independent schools and of the socio-economic and racial profiles of the independent schools sector. Table 6.6 depicts the proportions of each race group that were enrolled in public and independent institutions. The table indicates that white and Indian students were considerably more likely to attend independent schools than coloured and black students. Note that the sample has been restricted to include only those of a school-going age (defined as 6 to 18 inclusive) enrolled in pre-primary, primary and secondary schools.

Table 6.6: Proportions of students aged 6 to 18 in each sector by race group in 2007 (%)

	Public schools	Independent Schools	Total
Black	97.41	2.59	100
Coloured	96.87	3.13	100
Indian/Asian	85.67	14.33	100
White	79.71	20.29	100
Total	96.39	3.61	100

Source: Community Survey 2007

Figures 6.1 and 6.2 display the racial composition of public and independent schools, respectively, according to the Community Survey data. Black students made up the majority in both the public and independent school sectors. It is interesting that the estimate obtained from the Community Survey that 58.66% of students in independent schools were black is remarkably close to Du Toit's (2004) estimate of 58.3%, as reported in Table 6.5.

Figure 6.1: Racial composition of Public schools (CS 2007)

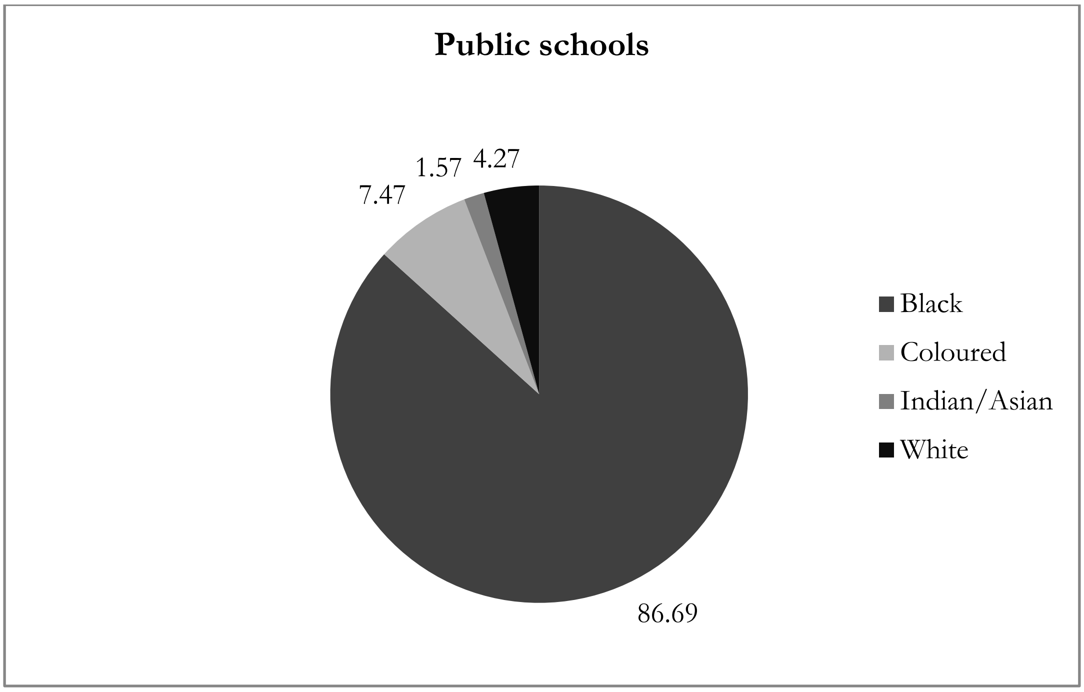
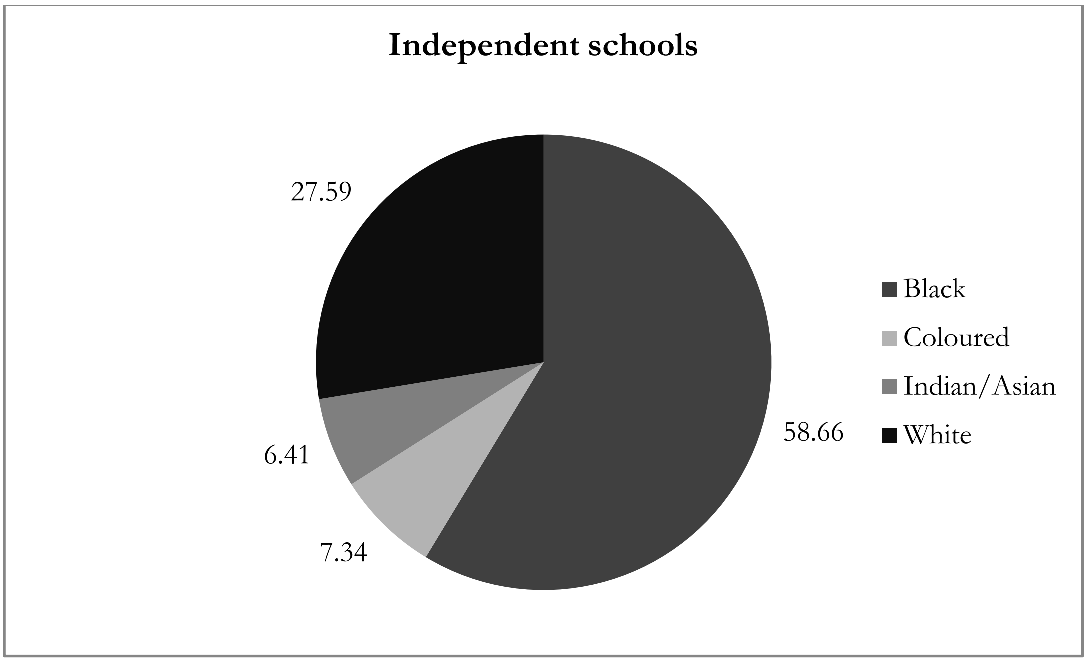


Figure 6.2: Racial composition of Independent schools (CS 2007)

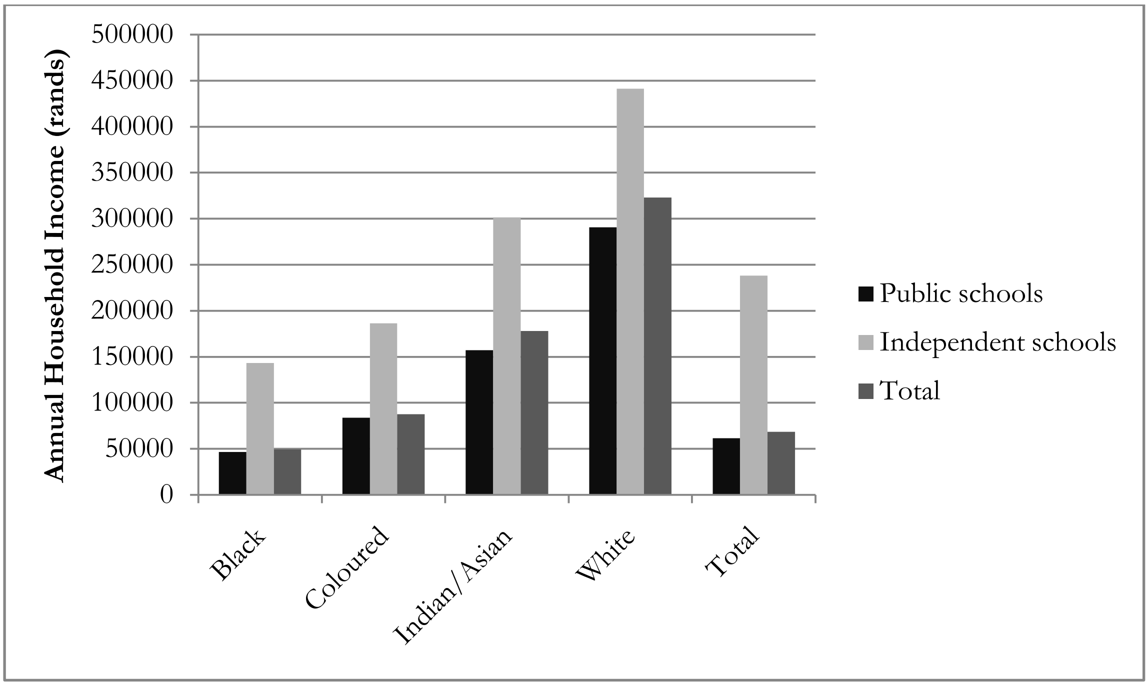


Although black students constituted a majority in independent schools, they represented a much bigger proportion of the public school sector. The Community Survey also reveals that the two sectors had very different socio-economic profiles. Table 6.7 reports the average annual household income by race and school sector, while Figure 6.3 depicts the same information in the form of a bar chart.[86] Unsurprisingly given South Africa's history and well-known persistent inequality, there were clear patterns by race with annual household income being highest amongst whites and then Indians, coloureds and blacks in that order. Moreover, it can be seen that within each race group the average annual household income was higher amongst those enrolled in independent schools than those in public schools. This indicates that independent schools have a more affluent pool of students to work with than do public schools.

Table 6.7: Average annual household income (in rands) by school sector and race group (CS 2007)

	Black	Coloured	Indian/Asian	White	Total
Public schools	46633	83700	157332	290579	61382
Independent schools	143319	186537	301443	441382	238232
Total	49307	87773	178179	322933	68491

Figure 6.3: Average annual household income by school sector and race group (CS 2007)



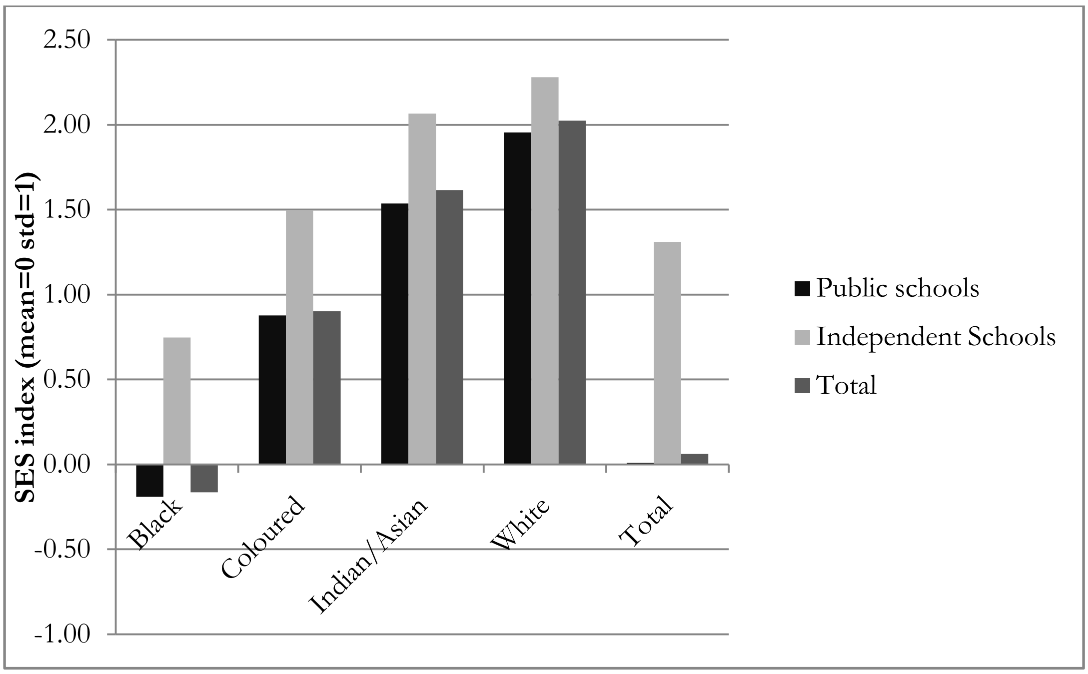
[86] The Community Survey suffered from widespread non-response and reported household incomes of zero. In order to deal with this, the "annual household income" variable was not used. Rather, the maximum *personal* annual income within each household was used as proxy for the income of the household. Of course this may underestimate total household income but it is perhaps a better proxy for SES, especially given the data limitations of the annual household income variable. As a result, the measure of household income used in Table 6.7 and Figure 6.3 has minimal non-response and a smaller proportion of reported incomes of zero. As a separate experiment testing whether this remaining non-response and reported incomes of zero affected the overall patterns evident in Table 6.7 and Figure 6.3, a value for household income was imputed for these cases. The value for imputation was obtained by predicting household income by race group and an asset-based index for SES. The derivation of this index is explained in the main text below. Using the new measure for household income including the imputed values in cases of non-response and reported incomes of zero raised the estimated averages across all categories by a small amount but did not change the overall patterns evident in Table 6.7 and Figure 6.3.

An alternative to annual household income as a measure of SES is to derive an asset-based index of household wealth. The latter is a longer-term indicator of wealth than annual income, a characteristic that might be considered advantageous when the purpose is to investigate the association of educational outcomes with SES. An index for household SES was generated by applying PCA to a number of variables in the Community Survey. These were household income and variables capturing whether the household had access to piped water, a toilet, a refrigerator, a radio, a computer, a television, a telephone, the internet and a cell phone. The resulting SES index was standardised to have a mean of zero and standard deviation of one. Table 6.8 and the associated bar chart in Figure 6.4 show the average household SES by school sector and race group. The same overall pattern that emerged when the outcome of interest was annual household income is now evident using the asset-based index for SES. There is a strong racial dimension to the distribution of SES, and within each race group average SES was higher for those who attended independent schools than those in public schools.

Table 6.8: Average household SES by school sector and race group (CS 2007)

	Black	Coloured	Indian/Asian	White	Total
Public schools	-0.19	0.88	1.54	1.95	0.01
Independent schools	0.75	1.50	2.07	2.28	1.31
Total	-0.16	0.90	1.61	2.02	0.06

Figure 6.4: Average household SES by school sector and race group (CS 2007)



The previous chapters have demonstrated that SES has a strong influence on educational outcomes. Therefore, the fact that for each race group those in independent schools are more affluent on average than those in public schools, gives the independent schools sector an initial advantage in the quest for educational achievement. The importance of accounting for these differences will be demonstrated in the next section, which analyses the performance of the two sectors as measured by matric pass rates.

6.3.2) Analysis of matric pass rates

6.3.2.1) The data

Two sources of data were merged using national EMIS[87] numbers in order to construct an appropriate dataset for the empirical analysis presented in this section. The number of students writing and passing matric in each school was obtained from the Senior Certificate database for 2006. Various other school characteristics such as information regarding the numbers of students and teachers in schools, pre-1994 education department and the level of expenditure and fees charged were obtained from the Annual Survey of Schools (ASS) for 2005. The ASS collects data using a school booklet (76 pages in 2005) and a one-page teacher form (each teacher completes one form). Provincial education departments administer the survey in all public and independent ordinary schools and capture the data. The DoE consolidates the data into a national database.

Tables 6.9 and 6.10 report summary statistics of the relevant variables for public and independent schools, respectively. Several qualifications regarding the variables should be noted before analysing the descriptive statistics. Only schools that offered matric were included as the matric pass rate will be the indicator of performance. The student-teacher ratio was calculated by dividing the number of students by the number of teachers at each school. The "funds" variable is the annual expenditure per student undertaken by the school itself and was calculated by dividing the total school expenditure for 2005 by the number of students. A second step in the derivation of the "funds" variable was to add R5 500 to the expenditure per student for each public school as this is approximately what the state spends on in kind inputs, notably teacher salaries. It is not appropriate to do the same for independent schools as they do not receive in kind contributions but only receive funding from the state, which would be included in the

[87] Education Management Information System

original expenditure. A third and final step was taken to derive the "funds" variable. One way of estimating funds per student is by multiplying the number of teachers at each school by an estimated teacher salary of R130 000 and then dividing this by the number of students. The mean of this estimate and the estimate obtained by adjusting expenditure per student for in kind inputs was therefore taken as the final "funds" variable. This led to a more credible picture of what funds per student looked like across the distribution of schools. In particular, this led to more credible estimates of funds per student for public schools with high student-teacher ratios and for independent schools with suspiciously low funds per student prior to the final adjustment.

The weighted means of "funds" and "fees" were calculated by attaching a weight to schools according to the number of students that wrote matric. This adjustment ensures that small and large schools do not carry the same weight in their influence on the means for the entire sector. Lastly, it was decided to exclude schools where fees were reportedly lower than R25. Bearing in mind that the data is from 2005, before the commencement of the "no-fee" schools policy, the reliability of such low reported fees is questionable.[88]

Table 6.9: Summary statistics for Public schools

Variable	Observations	Mean	Std. Dev.	Min	Max
<u>**From ASS 2005:**</u>					
Number of students	5734	681.42	397.01	4	2634
Grade 10 students	5651	176.52	119.6	4	893
Grade 11 students	5650	140.8	89.55	3	719
Number of teachers	5731	22.26	12.91	1	157
Student-teacher ratio	5711	31.6	22.36	3.72	1201
Funds (unweighted)	5719	5169.74	1335.54	601.85	18500
Funds (weighted)	5410	5135.82	1283.58	601.85	18500
Fees (unweighted)	5016	577.42	1471.91	25	20000
Fees (weighted)	5015	776.52	1802.56	25	20000
<u>**From matric database:**</u>					
Total wrote matric	5843	88	60.49	0	1173
Total passed matric	5843	57.19	46.86	0	391

[88] Moreover, further examination of a sample of cases where zero or extremely low fees were reported confirmed that these data entries should not be relied on.

Table 6.10: Summary statistics for Independent schools

Variable	Observations	Mean	Std. Dev.	Min	Max
From ASS 2005:					
Number of students	306	398.91	318.07	3	2659
Grade 10 students	294	58.44	58.35	1	476
Grade 11 students	295	53.61	46.42	2	335
Number of teachers	308	22.48	14.29	1	113
Student-teacher ratio	300	18.09	11.27	2.86	115.86
Funds (unweighted)	288	7812.25	3870.86	798.68	19259.26
Funds (weighted)	258	7127.86	3834.68	798.68	18352.94
Fees (unweighted)	217	4505.27	3459.91	25	20000
Fees (weighted)	217	4007.84	3024.43	25	20000
From matric database:					
Total wrote matric	351	57.55	72.61	1	567
Total passed matric	351	40.88	49.78	0	466

Comparing Tables 6.9 and 6.10 yields several interesting differences between public and independent schools. Firstly, there were far more public schools than independent schools in the dataset, as South Africa's independent schools sector is small in comparison to the public schools sector. There were 5,843 public schools and 351 independent schools in the dataset. The smaller number of independent schools means that for much of the analysis to follow in this section, statistical estimations relating to this sector were usually made with less precision than is the case for public schools.[89] Independent schools were considerably smaller on average than public schools as indicated by the total number of students in each school and confirmed by the average number of grade 10 students, grade 11 students and matric students. Despite having fewer students on average, independent schools had a very similar number of teachers per school to that of public schools. Consequently, the student-teacher ratio was smaller on average amongst independent schools. However, the student-teacher ratio did not prove to be a significant predictor of matric pass rates in the multivariate regression analysis to follow in this chapter. Therefore no further analysis of this variable is presented here.

[89] Strictly speaking it is incorrect to speak of a "sample" as the dataset is in fact the *population* of secondary schools in South Africa. Thus one might choose to ignore measures of statistical confidence such as standard errors of means, which express the degree of certainty with which estimations obtained from a sample accurately represent the population from which the sample was drawn. However, there is a sense in which a social reality outcome, such as the distribution of matric pass rates, is a sample of a data generating process that could have yielded any number of outcomes. Therefore, it was decided to report such statistics where appropriate to indicate the probability that similar estimates or results would be obtained if matric testing was repeatedly administered yielding different school pass rates each time. Put differently, these measures of statistical confidence indicate the level of certainty about a fundamental trend or mechanism underlying the data.

A further difference between public and independent schools that should be noted from Tables 6.9 and 6.10 is that the level of funding per student and the level of school fees was higher on average for independent schools. This trend held for both the weighted and unweighted calculations of the means. Another interesting trend emerging from Tables 6.9 and 6.10 is that in public schools the average number of students in grade 10 was noticeably higher than the average number of grade 11 students, which in turn was considerably higher than the average number that wrote matric in each school. In contrast, the average numbers in each grade were fairly stable for independent schools. Figure 6.5 shows this trend graphically.

Figure 6.5: Average number of students by grade and school sector

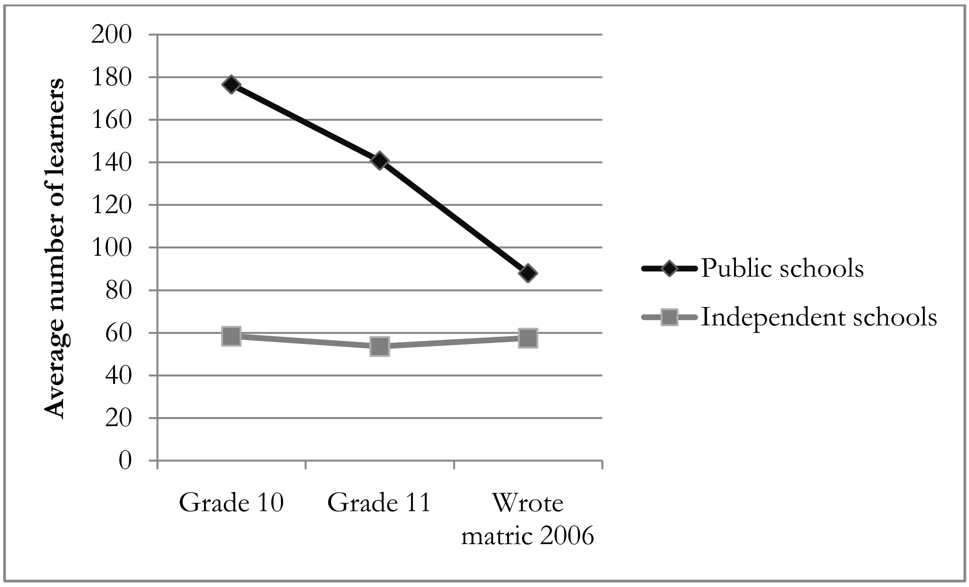


Figure 6.5 may indicate that the phenomenon of "weeding" is prevalent in public schools. Weeding refers to the practice of systematic non-promotion of weaker students into matric in order for schools to achieve a more impressive pass rate in the matric examination. The stability of the numbers from grade 10 to matric for independent schools is perhaps an indication of higher education quality prior to matric, demonstrated by a greater ability to convert reaching grade 10 into reaching matric. Alternatively, this pattern may be a reflection of greater motivation amongst parents and children in independent schools, leading to low drop-out rates. The difference between public and independent schools in this respect is dramatic, and therefore may deserve further investigation by policy-makers.

The pattern evident in Figure 6.5 is also consistent with what might be expected if there is a trend of inaccurate and lenient assessment practices in many schools, as discussed in Chapter 5.

If, due to inaccurate and lenient assessment, students progress through the earlier grades despite considerable learning deficits, it may be that the reality of a high stakes standardised evaluation in matric compels schools to assess students more strictly, leading to the extensive "weeding" that is apparent in Figure 6.5. As described in Chapter 5, the evidence suggests that assessment practices are weakest in historically black schools. Similarly, Lam *et al* (2008) found that grade progression contained a large stochastic component in schools attended by black students in the Western Cape. In the light of this, it was decided to decompose the "weeding" pattern by historical education department. Figure 6.6 shows that the phenomenon of "weeding" appeared to be most extensive in historically black and coloured schools. The numbers of public and independent schools by former department are reported in Table 6.11.

Figure 6.6: Average number of students by grade and former department (Public schools only)

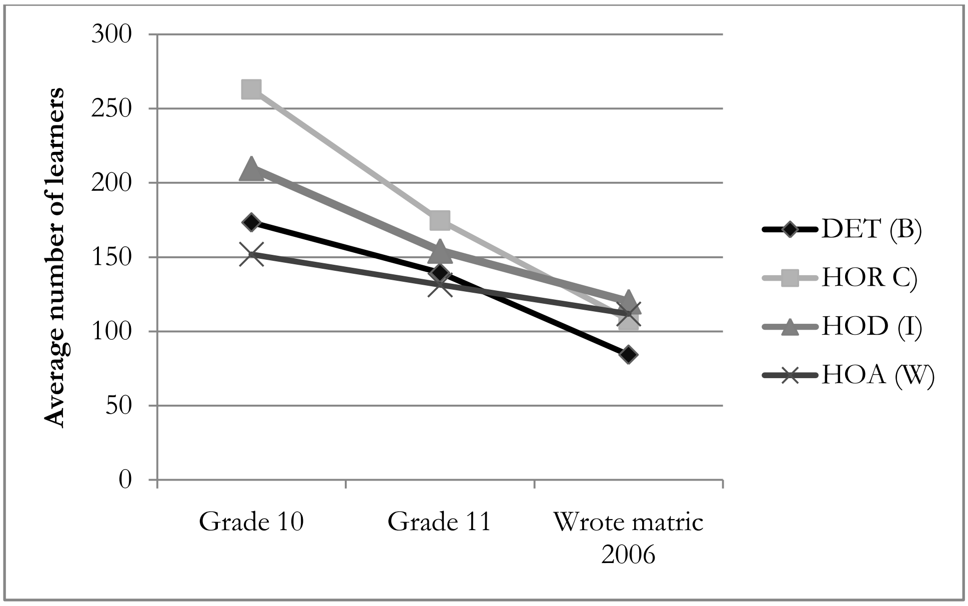


Table 6.11: Number of schools in the dataset by sector and former education department

Former department	Public schools	Independent schools	Total
DET (B)	4802	261	5063
	(82%)	(74%)	(82%)
HOR (C)	285	7	292
	(5%)	(2%)	(5%)
HOD (I)	152	4	156
	(3%)	(1%)	(3%)
HOA (W)	604	79	683
	(10%)	(23%)	(11%)
Total	5843	351	6194
	(100%)	(100%)	(100%)

Note: Column percentages in parenthesis

6.3.2.2) Descriptive analysis of matric pass rates and "conversion rates"

The simplest way to calculate matric pass rates for each school is to divide the total number of students that passed matric in 2006 by the total number that wrote matric, and then multiply by 100 to convert this into a percentage. Using this calculation, the average pass rate amongst public schools was 65.1% compared to 77.1% amongst independent schools. Table 6.12 reports this together with various other ways of expressing the performance of the two sectors at producing matric passes. When schools were weighted according to the number that wrote matric the difference in average pass rates between the two sectors was somewhat smaller, the gap being slightly over 7 percentage points. This narrowing of the gap when the weighting was applied reflects the fact that many of the top performing independent schools were small. The "adjusted pass rates" reported in Table 6.12 were constructed in an attempt to control for the practice of "weeding". This adjustment involved changing the denominator to be the number of students in grade 10 for schools where the number of grade 10 students was greater than the number that wrote matric. Therefore, the adjusted pass rates are given by the following formulas:

For schools in which the number of grade 10 students was less than the number that wrote matric:

*Adjusted pass rate = (total number that passed matric / total number that wrote matric)*100.*

For schools in which the number of grade 10 students was less than the number that wrote matric:

*Adjusted pass rate = (total number that passed matric / total number enrolled in grade 10)*100.*

Table 6.12: Different versions of the average matric pass rate by sector

	Public schools	Independent schools	Total
Unweighted pass rate	65.1	77.1	65.7
Weighted pass rate	66.1	73.3	66.4
Unweighted adjusted pass rate	34.6	57.0	35.7
Weighted adjusted pass rate	38.1	59.4	38.7

The average "adjusted pass rates" were considerably lower than the original pass rates due to the greater numbers in grade 10 than in matric. This difference was especially large for public schools due to the low progression from grade 10 to matric, as Figure 6.5 demonstrated. It is therefore more correct to think of the "adjusted pass rates" as the rate of conversion of grade 10 enrolments into matric passes. The weighted adjusted pass rates are thus probably the best estimation of the success of the two sectors in producing matric passes. This was confirmed by better model fit in the multivariate regression analysis that is discussed in the next section. According to this measure, independent schools enjoyed an advantage of approximately 21 percentage points.

The message from the above table is that independent schools performed considerably better on average than public schools, before controlling for factors such as the resource base of the schools or the SES of the student bodies. This is confirmed by Figure 6.7 and 6.8, which show percentile plots of the mean pass rates and adjusted pass rates, respectively, for each sector. By splitting the performance of each sector into percentiles, these plots offer a comparison between public and independent schools across the distribution of performance.

Figure 6.7: Percentile plots of mean pass rate by sector

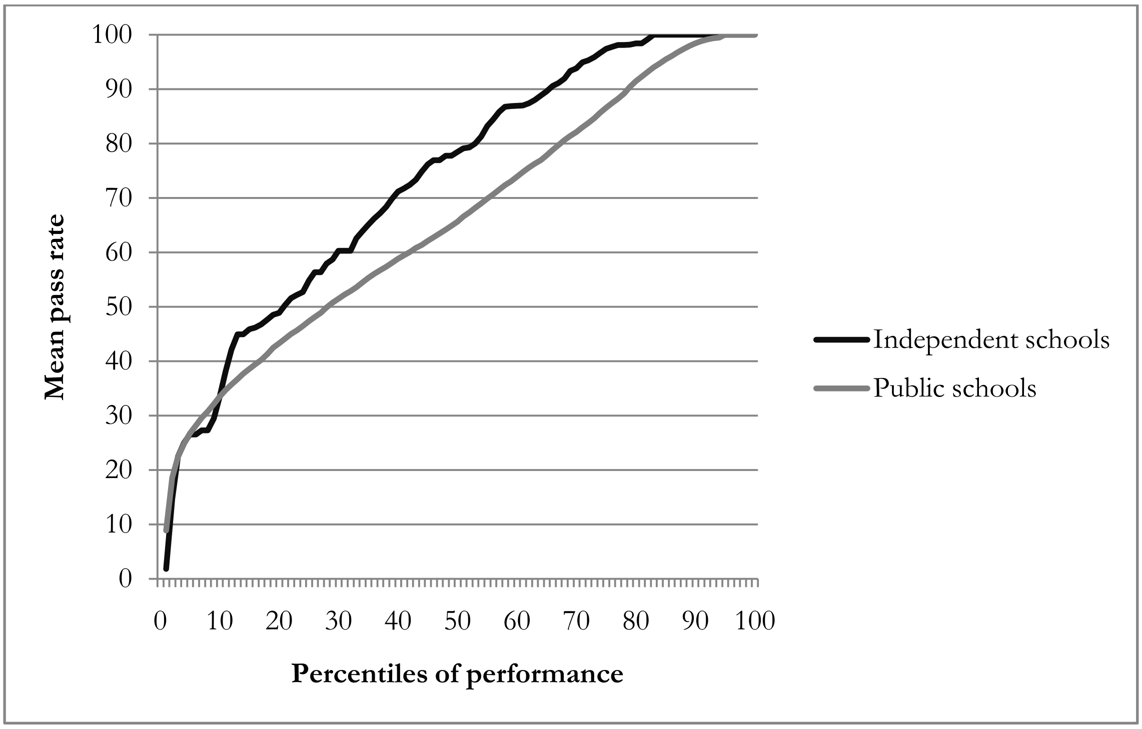
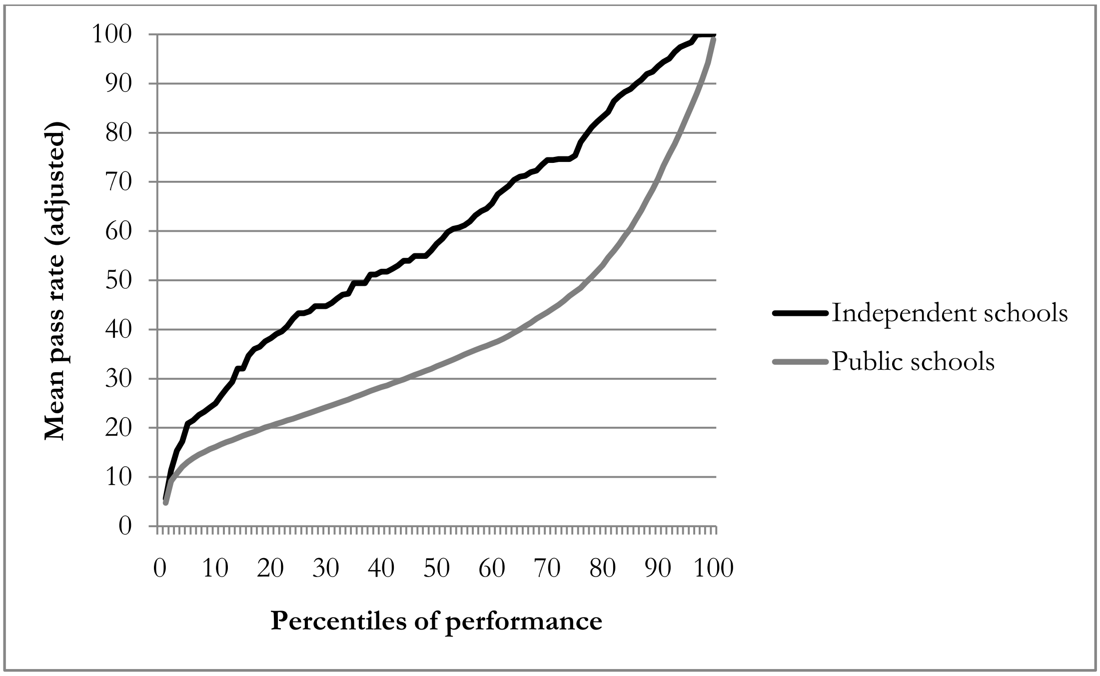


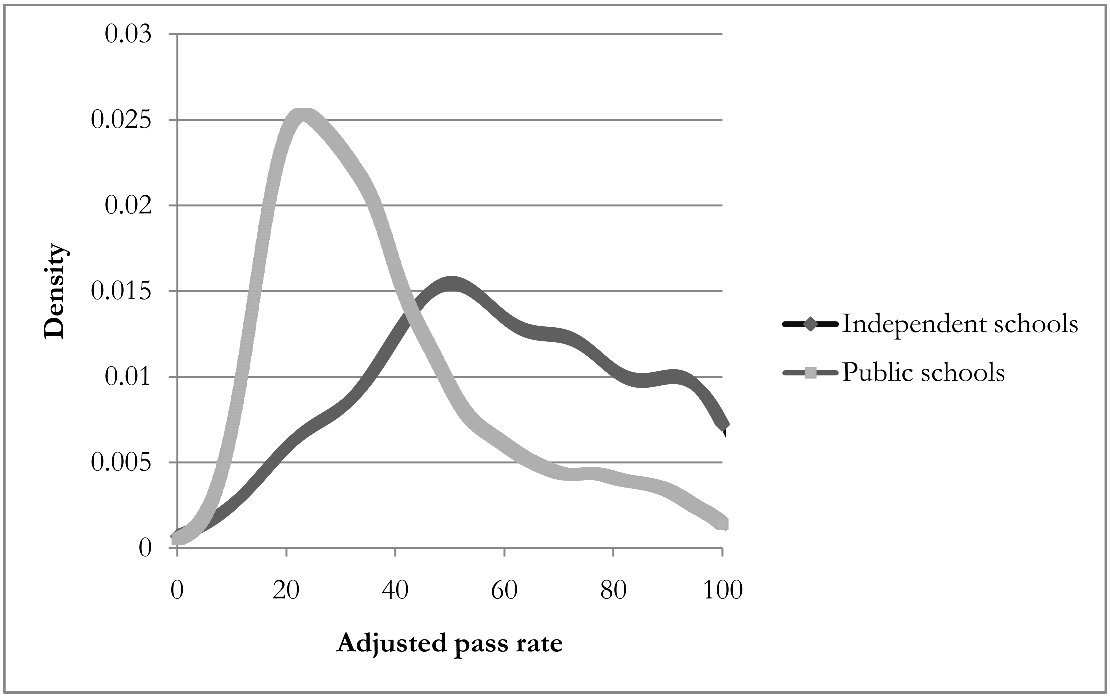
Figure 6.7 shows that at almost every point in each sector's distribution of performance, the average pass rate is higher for independent schools than for public schools at the corresponding percentile of performance. The difference in pass rates between public and independent schools across the distribution is more substantial when the pass rate is adjusted for so-called "weeding", as Figure 6.8 demonstrates. This again indicates that weeding is more prevalent within public schools than independent schools.

Figure 6.8: Percentile plots of mean adjusted pass rate by sector



Another way of looking at the distribution of performance in the two sectors is by plotting kernel density curves, as done in Figure 6.9 below. It is clear from Figure 6.9 that the distribution of the adjusted pass rates (or rate of conversion from grade 10 to matric passes) was denser at the bottom end for the public sector than the independent sector. Conversely, there was a greater concentration at the top end for independent schools than for public schools. Moreover, the mode of the adjusted pass rate was considerably higher for independent schools than public schools. Put differently, the bulk of the distribution of performance for independent schools lay to the right of that of public sector schools.

Figure 6.9: Kernel density curves of mean adjusted pass rate by sector



All the above analysis did not condition on any characteristics of schools or students. It is already evident from the summary statistics that there were considerable differences between public and independent schools with respect to the level of funding, the fees that were charged (which can be considered a proxy for the SES of the student body), etc. The policy-relevant question is whether the independent schooling sector still performs better than the public sector once these other factors are controlled for. Table 6.13 compares the performance of each sector and adds the former education department of schools to the analysis.

Table 6.13: Mean pass rate by sector and former department

Sector	Obs	Mean	Std. Err.	95% Confidence Interval	
DET, Public	4798	59.4%	0.31	58.82	60.02
DET, Independent	261	68.5%	1.57	65.39	71.58
HOR, Public	285	77.0%	0.90	75.25	78.80
HOR, Independent	7	91.6%	3.22	83.70	99.44
HOD, Public	152	87.6%	0.94	85.75	89.46
HOD, Independent	4	88.6%	10.59	54.87	122.29
HOA, Public	607	96.4%	0.33	95.76	97.06
HOA, Independent	79	91.7%	1.32	89.05	94.30
Total, Public	5842	66.09%	0.31	65.49	66.69
Total, Independent	351	73.31%	1.34	70.70	75.96

The mean pass rates and 95% confidence intervals reported above in Table 6.13 are presented graphically in Figure 6.10. As might be expected, the historically white (HOA) and Indian (HOD) schools had higher pass rates on average than historically coloured (HOR) and black (DET) schools. A noteworthy feature, however, is that historically black independent schools achieved higher matric pass rates on average than historically black public schools. Similarly, independent schools had a performance advantage amongst historically coloured schools. In contrast, public schools achieved higher pass rates on average than independent schools amongst historically white schools. Small sample size for historically Indian independent schools, causing a wide confidence interval, detracts from the value of comparison within this category.

Figure 6.10: Mean pass rate and 95% confidence intervals by sector and former department

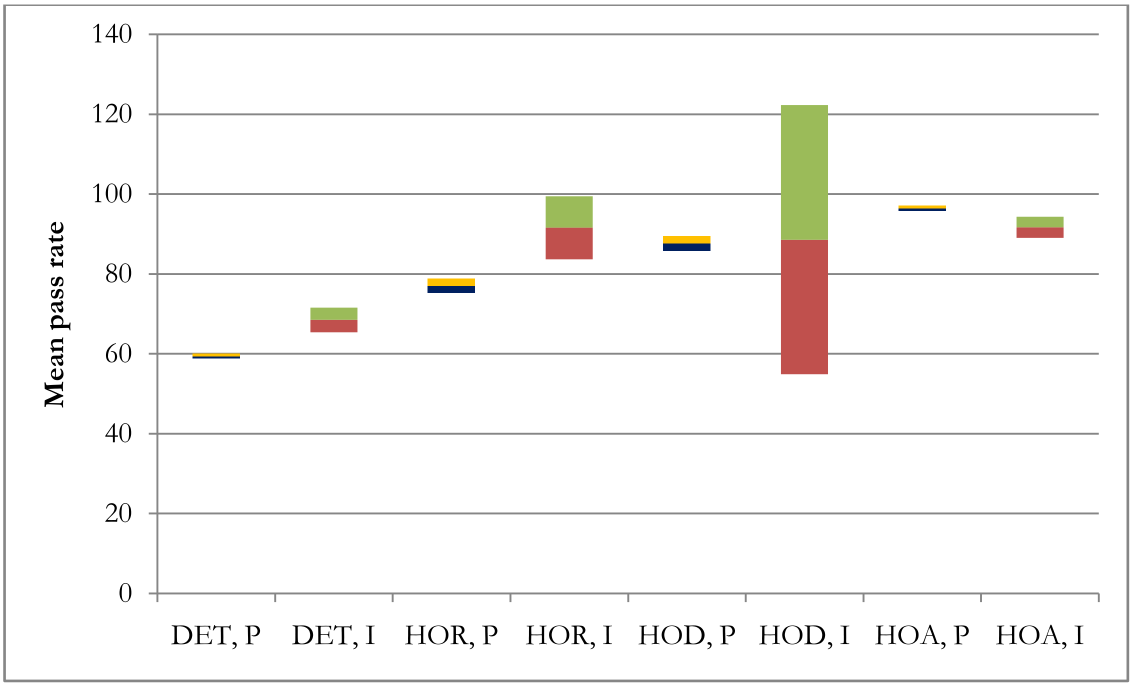


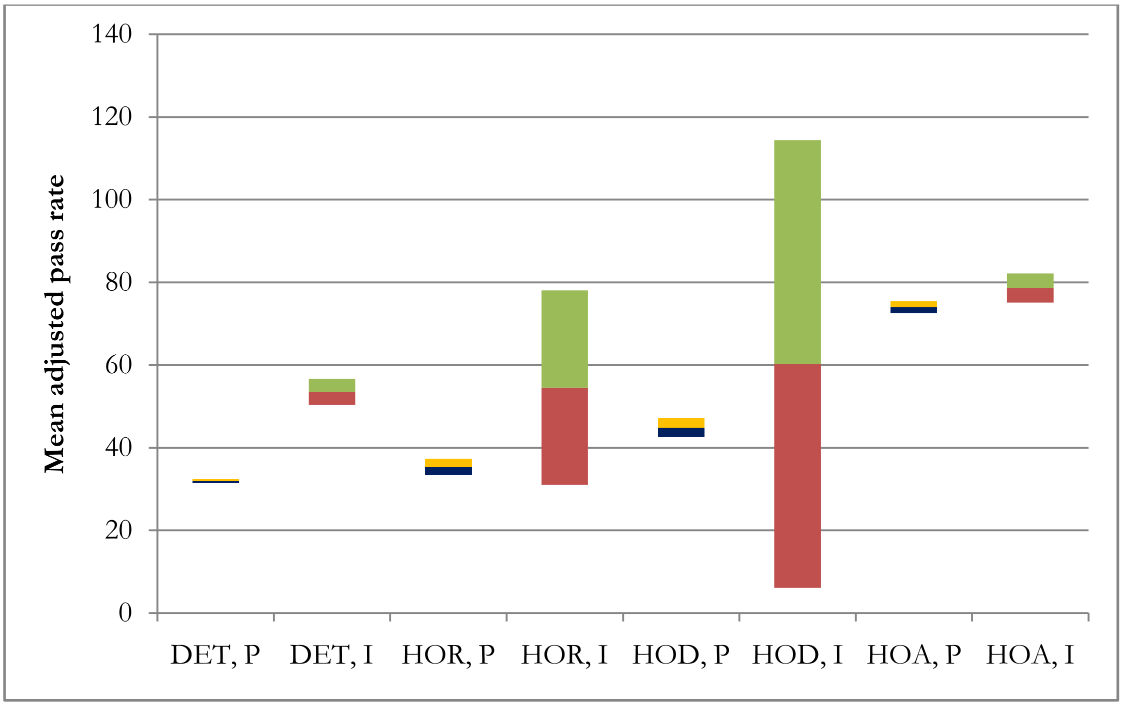
Table 6.14 and Figure 6.11 present a similar picture. Here, the adjusted pass rates are compared across sector and former department. The performance advantage of the independent sector amongst historically black and coloured schools was even larger than when comparing simple pass rates – in the region of 20 percentage points in both cases. Historically black and coloured schools constitute the vast majority of the school system and serve the bulk of South Africa's low SES and historically disadvantaged students. The need to improve educational outcomes amongst these schools for the sake of social transformation is clear. The superior performance of independent historically black and coloured schools relative to their public sector counterparts

is therefore a potentially important finding. This apparent advantage will be more thoroughly investigated as this chapter proceeds.

Table 6.14: Mean adjusted pass rate by sector and former department

Sector	Obs	Mean	Std. Err.	95% Confidence Interval	
DET, Public	4617	31.9%	0.22	31.44	32.31
DET, Independent	208	53.5%	1.60	50.35	56.66
HOR, Public	281	35.4%	0.99	33.42	37.31
HOR, Independent	6	54.6%	9.15	31.04	78.07
HOD, Public	149	44.8%	1.15	42.58	47.11
HOD, Independent	3	60.2%	12.59	6.08	114.40
HOA, Public	603	74.0%	0.72	72.59	75.40
HOA, Independent	77	78.7%	1.77	75.12	82.18
Total, Public	5650	38.08%	0.28	37.53	38.63
Total, Independent	294	59.40%	1.40	56.65	62.15

Figure 6.11: Mean adjusted pass rate and 95% confidence intervals by sector and former department

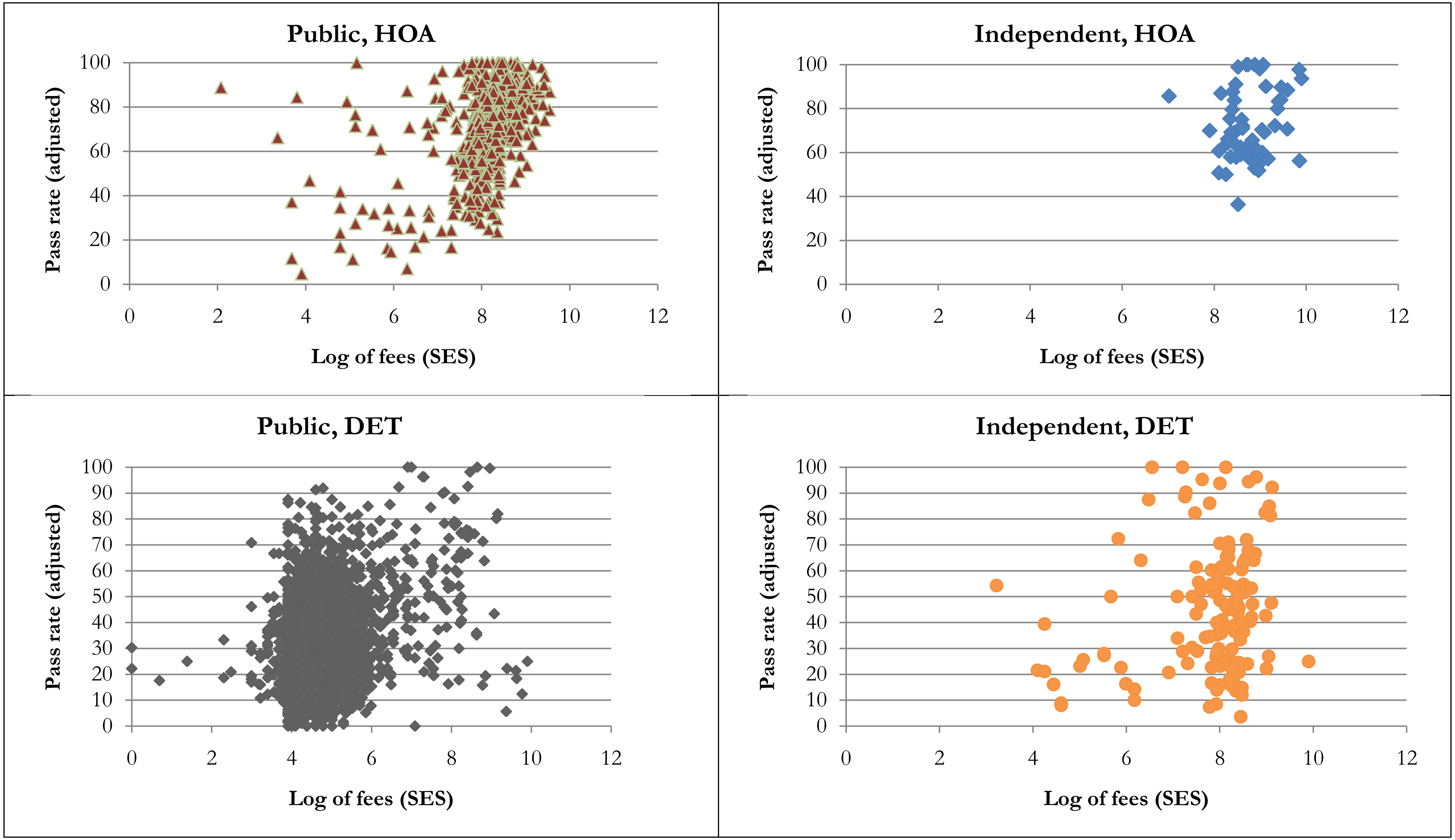


Undoubtedly, there was a performance advantage for the independent sector within the historically black and coloured parts of the school system. One explanation, however, could be that differences in student SES were driving the performance gaps between these groups of schools. Figure 6.12 demonstrates that, within each historical division, there were considerable differences between the socio-economic profiles of independent and public schools. The figure shows four panels of scatterplots of the adjusted pass rate against the log of school fees, for historically white (HOA) public and independent schools, and for historically black (DET) public and independent schools. Note that the school fee charged by each school was the best proxy for the SES of the student body amongst the available data, and will therefore be interpreted as such for most of the forthcoming analysis. Due to the small number of historically coloured and Indian independent schools in the sample, Figure 6.12 was restricted to historically black and white schools. The numbers of schools and mean log of fees for each of the categories in the scatterplots of Figure 6.12 are reported in Table 6.15.

Table 6.15: Mean school fees by school category

Category	Number of schools	mean log of fees
Public, HOA	453	8.22
Independent, HOA	56	8.74
Public, DET	4193	4.93
Independent, DET	134	7.58

Figure 6.12: Scatterplots of fees and pass rates by sector and former education department



It is evident that within both former departments, independent schools served a more affluent student body than public schools. Thus it is unclear whether, and to what extent, the superior performance of independent schools is attributable to the fact that these schools served more affluent children. This necessitates the use of multivariate regression analysis in order to estimate the effect of being in an independent school conditional upon all the other relevant and available variables. This form of analysis is pursued in the next section. First, however, consider the performance of independent and public schools conditional only upon the level of funding per student in each school. Glewwe (2002) regards the use of performance per dollar spent on education as a viable measure of the efficiency or cost-effectiveness of schools. This concept was appropriated to derive a measure of efficiency using the data at hand. The adjusted pass rate in each school was divided by the number of rands of funding per student and then multiplied by 100. The measure is thus the adjusted pass rate increment per R100 of funding per student.

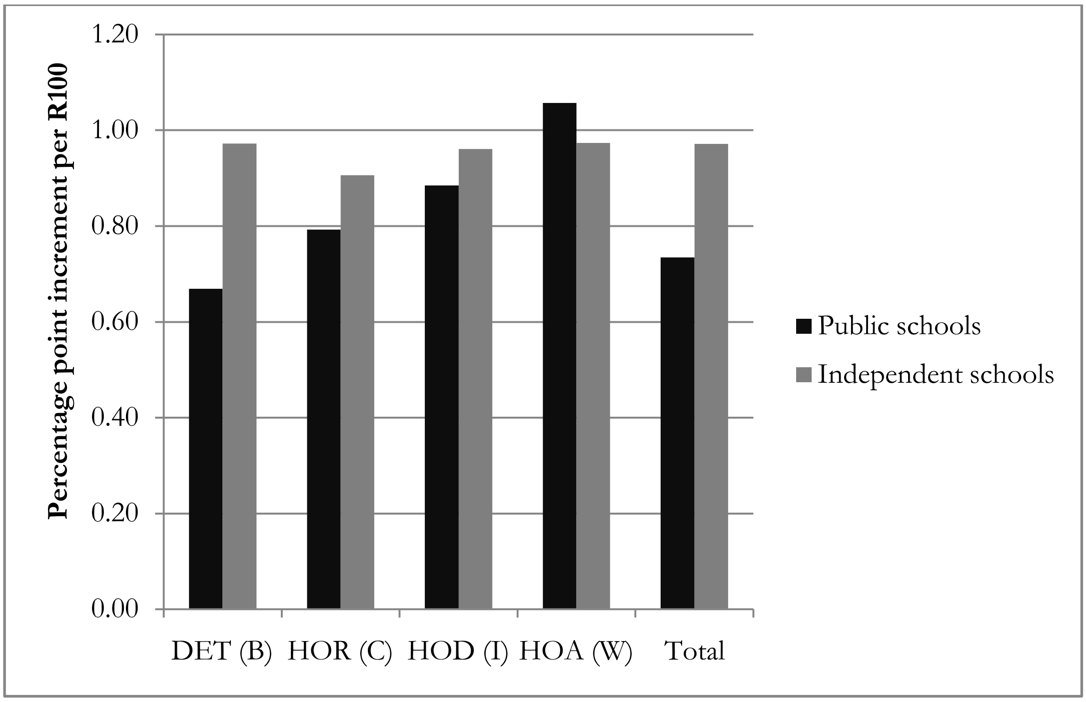
Table 6.16 demonstrates that independent schools achieved a higher level of efficiency, according to this measure. Every R100 per student that was spent in independent schools can be thought to have "bought" almost a one percentage point increment in the adjusted pass rate. In public schools the same R100 only "bought" 0.73 percentage points.

Table 6.16: Pass rate increment (percentage points) per R100 of funding per student

	Average	Std.dev.	obs.
Public schools	0.73	0.34	5634
Independent schools	0.97	0.45	273
Total	0.74	0.34	5907

Figure 6.13 shows this measure of efficiency by school sector as well as former education department. The most noteworthy aspect of the figure is that R100 spent on historically black independent schools appears to have "bought" considerably more performance than R100 that was spent within historically black public schools. This result, taken together with the preceding analysis, would suggest that independent schools enjoy an overall performance and efficiency advantage over public schools in South Africa, and that this is largely driven by differences within the historically black part of the system. The multivariate analysis to follow provides a more rigorous interrogation of this finding.

Figure 6.13: Average adjusted pass rate increment (percentage points) per R100 of funding per student by former department



6.3.2.3) Multivariate regression analysis

A model for the educational performance of schools, using the data available, could be described by the following function:

$Y = f(F, SES, S, D)$

The educational performance (*Y*), as measured by the matric pass rate or the adjusted pass rate, is a function of the level of funding in each school (*F*), the home background or SES of the students at each school, the sector of the school (*S*) which is either independent or public, and the former education department (*D*). The funds per student in each school can be used to represent *F*, while the school fee charged is the best proxy available for *SES*. The summary statistics for these variables were presented in Tables 6.9 and 6.10.

Table 6.17 reports the results of six Ordinary Least Squares regression models.[90] In models [A] and [B] the dependent variable was the matric pass rate in each school, while models [C], [D], [E] and [F] used the adjusted pass rate as the dependent variable. The level of funds per student and the fees variable were entered in log form in order to approximate a more normal distribution for these variables.

In model [A] the matric pass rate was predicted by the funds per student and the independent school dummy. The R-squared statistic indicates that these two variables alone accounted for about 11.5% of the variation in matric pass rates between schools. A large, positive and statistically significant effect of funds per student was obtained. A fairly small yet statistically significant positive effect (3.53 percentage points) of being an independent school was obtained. Model [B] describes the independent school effect conditional upon funding per student together with school fees. The explanatory power of this model is considerably greater than that of model [A]. An estimated 32.8% of the variation in matric pass rates was explained by model [B]. This improvement in the model fit was due largely to the inclusion of fees, as the coefficient on the log of funds per student was no longer statistically significant. The log of school fees had a large, positive and statistically significant effect on school performance. This is indicative of the powerful influence of SES on educational outcomes in South Africa. Interestingly, the coefficient on the independent school dummy was negative and significant in model [B]. Thus, for given levels of school fees (SES) and funding, the expected matric pass rate was actually lower for independent schools than for public schools.

The dependent variable in models [C], [D], [E] and [F] was the adjusted pass rate, which penalises schools for "weeding" and is therefore a better indicator of performance than the simple matric pass rate, as argued earlier. Model [C] included the same set of explanatory variables as model [B] but produced a substantially better model fit due to the use of the adjusted pass rate as the dependent variable. This provides support for the contention that this is the more appropriate indicator of performance than the simple matric pass rate. The coefficients on the log of funds and the log of fees were both significant and positive, while the effect of the independent school dummy was not significantly different from zero. This implies that the apparent performance advantage of public schools that was obtained in model [B] was nullified once "weeding" had been taken into account.

[90] In all the models, schools were weighted according to the total number of students that wrote matric.

Table 6.17: Multivariate regression analysis predicting matric pass rate and the adjusted pass rate

	[A]	[B]	[C]	[D]	[E]	[F]
Dependent variable	**pass rate[91]**	**pass rate**	**adjusted pass rate[92]**	**adjusted pass rate**	**adjusted pass rate**	**adjusted pass rate**
Explanatory variables						
Log of funds per student	32.91 (27.22)**	2.74 (1.78)	0.22 (18.16)**	23.31(18.89)**	16.53 (13.19)**	17.38 (13.80)**
Independent school	3.53 (2.14)*	-16.68 (9.41)**	-0.03 (1.93)	50.95(7.03)**	2.60 (1.79)	39.84 (5.61)**
Log of fees	–	9.89 (38.45)**	0.08 (38.69)**	8.05(39.38)**	4.99 (17.79)**	5.24 (18.18)**
Log of fees_x_independent	–	–	–	-6.99(7.56)**	–	-4.88 (5.36)**
HOA (W)	–	–	–	–	18.08 (16.48)**	17.18 (15.52)**
HOD (I)	–	–	–	–	3.89 (3.15)**	3.50 (2.84)**
HOR (C)	–	–	–	–	-2.50 (1.99)*	-2.74 (2.19)*
Constant	-213.92 (20.78)**	-11.75 (0.95)	-1.97 (19.91)**	-204.86(20.73)**	-132.69	-141.12 (13.57)**
R-squared	0.1152	0.3281	0.4752	0.4810	0.5048	0.5076
Observations	6006	5170	5089	5089	5089	5089

*Significant at the 5% level   **Significant at the 1% level

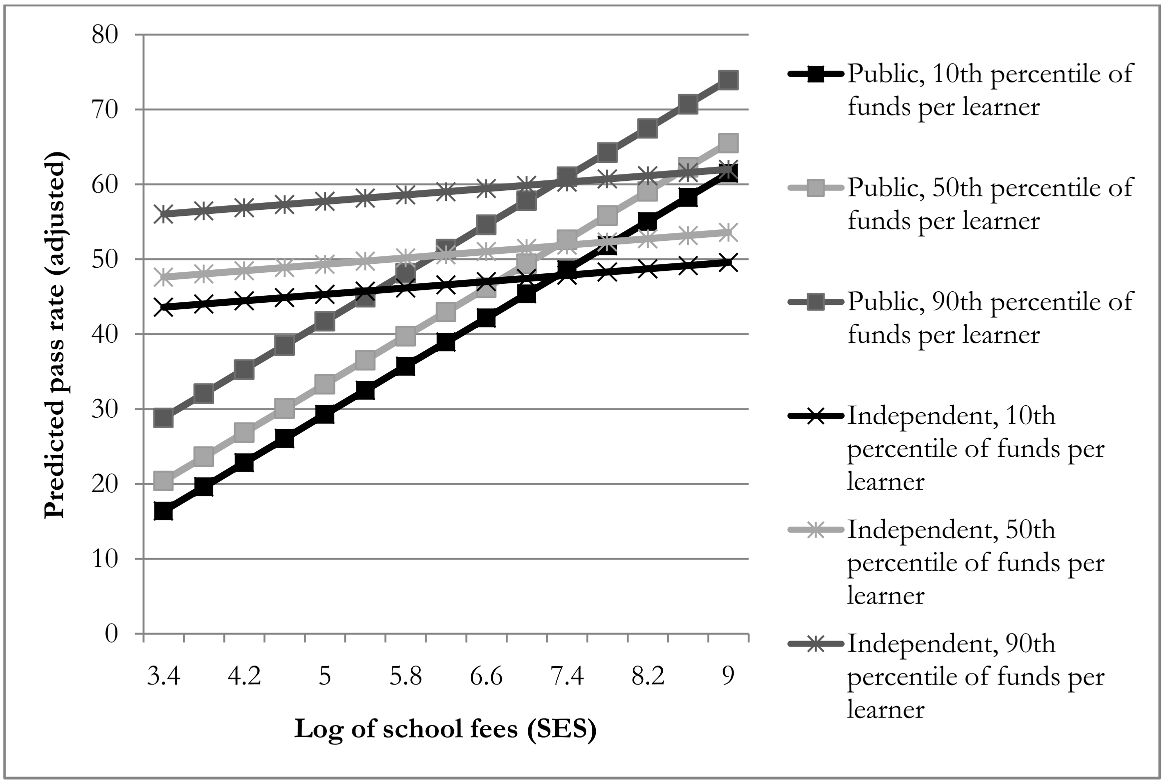
Absolute values of t-statistics in parentheses

[91] Pass rate = (total number that passed matric / total number that wrote matric)*100

[92] If the number of matriculants was greater than the number of grade 10 students then: Adjusted pass rate = (total number that passed matric / total number that wrote matric)*100. If the number of matriculants was less than the number of grade 10 students then: Adjusted pass rate = (total number that passed matric / total number that were enrolled in grade 10)*100.

In model [D] the log of school fees was allowed to interact with the type of school (independent or public). This means that the model is sensitive to the possibility that school fees (SES) may influence performance differently within the independent sector from how it does within the public sector. All the coefficients in model [D] were significantly different from zero. In order to ease the interpretation of the estimated effects in model [D], they are presented graphically in Figure 6.14. The figure shows the relationship between SES (proxied by the log of fees) and school performance (measured by the adjusted pass rate) for each school sector at different levels of funding per student. The less steep slopes for the independent schools indicate that the level of fees charged had a less pronounced effect on performance in this sector than it did amongst public sector schools. Moreover, the figure demonstrates that it cannot be said unequivocally that either sector had a higher expected performance once school fees were held constant. Rather, it can be said that amongst medium to low SES schools the independent sector appeared to perform better than the public sector. This may hold important policy implications.

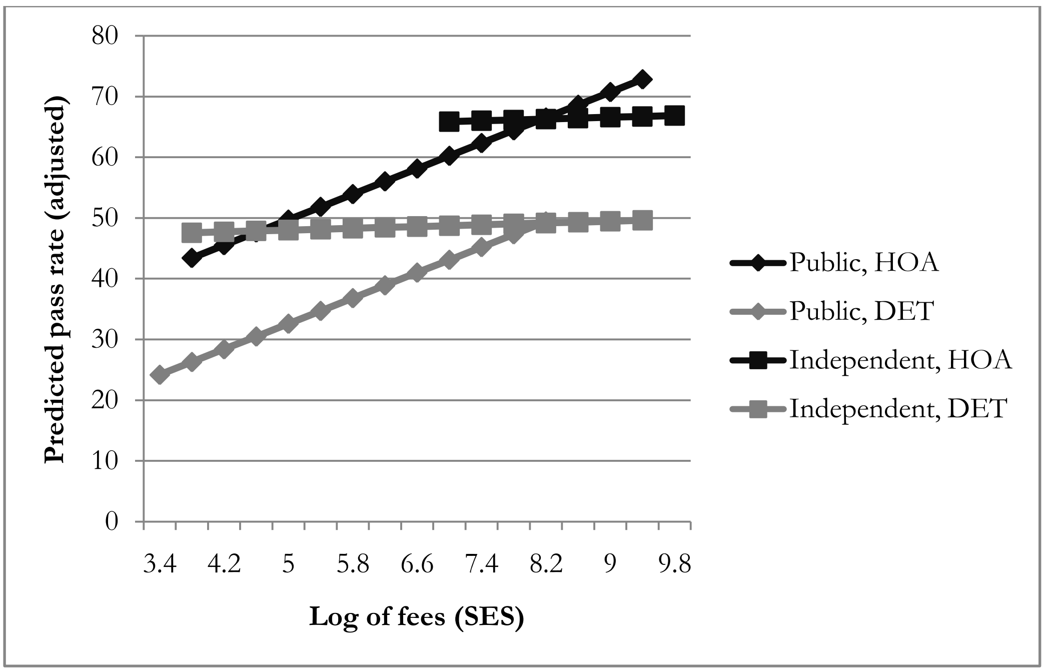
Figure 6.14: Graphical representation of Regression [D]



Model [E] did not allow for the interaction between school type and fees, but did introduce dummy variables for the former education departments, with ex-DET schools as the reference category. The results indicate that historically white and Indian schools performed better than historically black schools while historically coloured schools performed marginally worse than historically black schools, after controlling for funds, fees and school type. Model [F] included the interaction between school type and fees, and can be considered to be the most complete model. The explanatory power of this model is fairly pleasing, as the R-squared statistic indicates: over 50% of the total variation on adjusted pass rates was accounted for by the model. As before, a graphical presentation of the results offers a more accessible interpretation.

For Figure 6.15, all four categories of school depicted were split into percentiles of school fees. The lengths of the lines in the graph were determined by showing only the predicted pass rates for the range of school fees between the 2nd and the 99th percentile within each group, in order to give an impression of the socio-economic profiles of these groups of schools. The estimates for historically Indian and coloured schools were not plotted in the figure so as to retain an uncluttered picture and due to small sample size. The figure indicates that historically white (HOA) independent schools served a fairly high SES group of students, but did not appear to perform substantially differently to historically white public schools of comparable SES. Of greater interest is the result that historically black independent schools performed better than historically black public schools throughout most of the socio-economic distribution. At lower fee levels the difference in predicted pass rate (adjusted) approached 20 percentage points. Also, within the independent sector the effect of the level of fees charged was less pronounced.

Figure 6.15: Graphical representation of Regression [F]



Notes: At the median level of funds per student
(range=2nd to the 99th percentile of SES)

Table 6.18 displays two more regression models using an alternative version of SES. For the derivation of this measure of SES, the asset-based index of SES calculated from the Community Survey, as explained earlier in section 6.3.1, was divided into percentiles, separately for those enrolled in public and independent schools. Similarly, in the Annual Survey of Schools dataset, schools were divided into percentiles according to the level of fees charged. Again, this was done separately for public and independent schools. The mean SES within each percentile in the Community Survey was then imputed into the Annual Survey of Schools dataset by matching on percentiles, separately for each school sector.

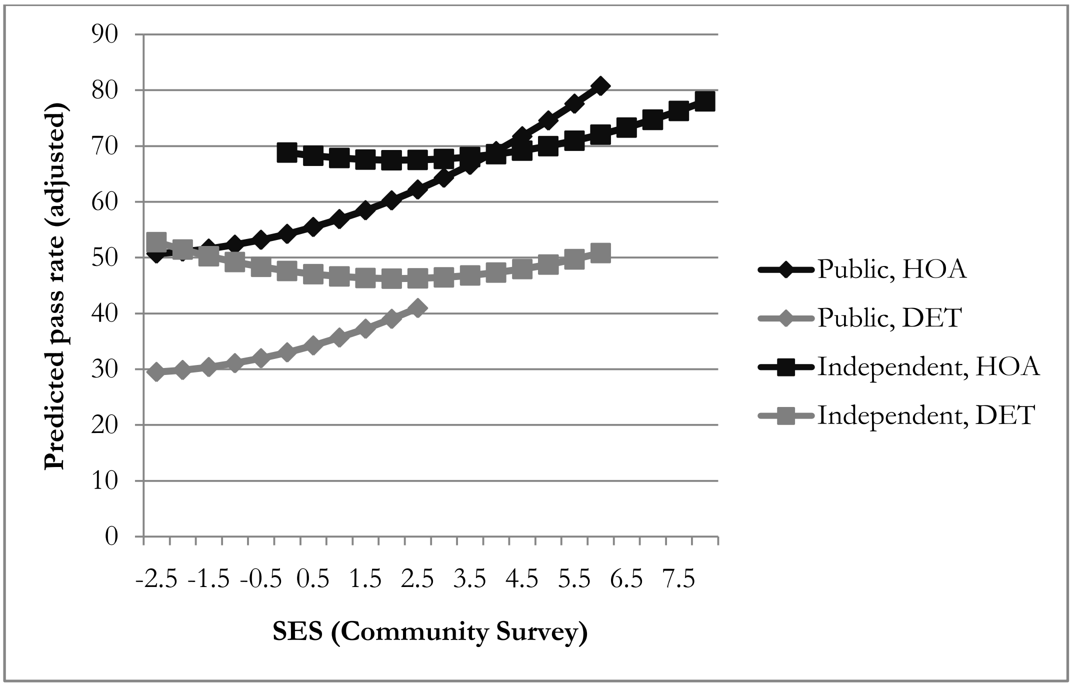
In models [G] and [H] presented in Table 6.18, this asset-based SES index was included instead of the log of school fees. The results therefore show what the effect of household SES on school performance would be if the level of school fees was an accurate sorter of SES. Model [G] has the same specification as model [F] above, except with SES in the place of school fees. A very similar overall model fit and combination of estimated effects were obtained. In model [H] the square of SES and the interaction between school type and the square of SES were also included to allow for a non-linear effect of SES on performance. The positive statistically significant coefficient on "SES_squared" is evidence of non-linearity – at higher levels of SES the effect was larger. To assist with the interpretation of model [H] the estimates have been plotted graphically in Figure 6.16.

Table 6.18: Multivariate regression analysis using SES derived from Community Survey (2007)

Dependent variable	**[G]** **adjusted pass rate**	**[H]** **adjusted pass rate**
Explanatory variables		
Log of funds per student	19.20 (15.24)**	16.68 (12.79)**
Independent school	14.21 (7.47)**	14.61 (7.70)**
HOA (W)	23.64 (24.85)**	21.30 (21.28)**
HOD (I)	5.66 (4.61)**	5.66 (4.63)**
HOR (C)	-1.61 (1.28)	-1.64 (1.31)
SES	4.54 (15.31)**	4.34 (14.64)**
SES_x_independent	-5.21 (4.92)**	-6.82 (3.40)**
SES_squared		1.28 (7.07)**
SES_squared_x_ind.		-0.18 (0.25)
Constant	-129.05 (12.05)**	-108.63 (9.83)**
R-squared	0.4979	0.503
Observations	5089	5089

*Significant at the 5% level **Significant at the 1% level
Absolute values of t-statistics in parentheses

Figure 6.16: Graphical representation of Regression [H]

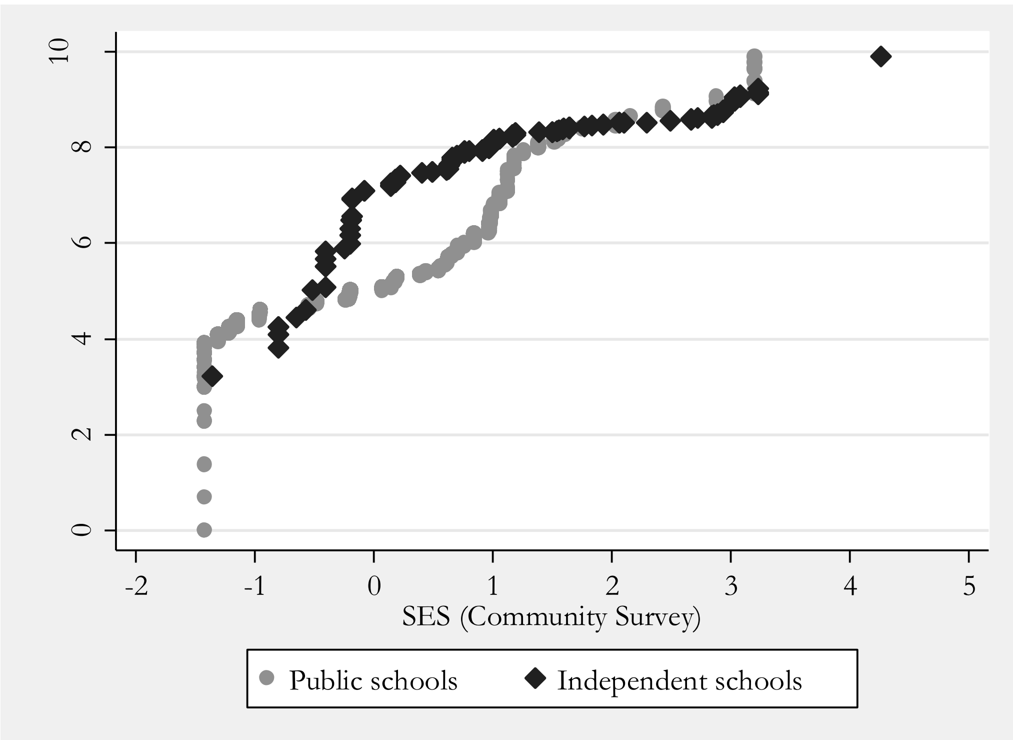


Notes: At the median level of funds per student
(range=2nd to the 99th percentile of SES)

Figure 6.16 confirms the finding that amongst historically black schools, the independent sector had a higher rate of conversion into matric passes than the public sector, after SES and the level of funding per student had been controlled for. This is a potentially important finding given that historically black schools constitute the majority of the less well-functioning part of the school system and are therefore highest on the policy agenda. It is possible that an expansion of the independent sector targeting poor and predominantly black communities could lead to an improvement in educational performance. However, this policy action cannot be advocated without reservation due to uncertainty about the channels through which historically black independent schools achieve an advantage. It could be that particular school characteristics or teaching methods that are prevalent amongst these schools are driving the advantage and could feasibly be appropriated into public schools. Or it could be that a selection bias is at work: students who are particularly motivated and students with parents who value education may be inclined to choose independent schools over public schools. This same motivational quality would then also contribute to higher educational achievement. It is not possible to investigate this selection bias thoroughly with the data available. A fairly rich set of student level characteristics would be necessary for this. Nevertheless, one thing that can be done is to compare the level of school fees that parents of identical SES (according to the Community Survey) pay in each of the two school sectors.

Figure 6.17 presents scatterplots of the log of school fees at every level of SES for each school sector. The sample was restricted to historically black schools as this is where the most interesting and potentially important pattern has been emerging, in Figure 6.16 for example. The scatterplots reveal that in the area between an SES score of about -1 and 1.8, in which approximately 77% of historically black schools were located, independent school parents paid considerably higher fees than public school parents of the same SES. The willingness to pay higher school fees that is evident amongst independent schools parents, is probably an indication that these parents place greater value on education than parents of the same SES that choose public schools. This implies at least one of two possibilities. Firstly, parents who value education are willing to pay more in order to secure access to independent schools, which offer better educational opportunities. Or it may be that those parents themselves contribute to the better outcomes of their children and the schools they attend through being more involved in their children's education and school life. A combination of these two factors could be at work, in varying degrees across schools.

Figure 6.17: Scatterplots of school fees by SES and school sector for those in historically black schools



Interestingly, the advantage in efficiency, measured by pass rate increment per R100 of funding per student, enjoyed by the independent sector as a whole, persisted within this sub-sample of historically black schools between SES levels of -1 and 1.8. Table 6.19 demonstrates that the size of this efficiency advantage was similar to that obtained for the full sample as reported in Table 6.16.

Table 6.19: Pass rate increment (percentage points) per R100 of funding per student for sub-sample

	Average
Public schools	0.68
Independent schools	0.91

6.4) Chapter conclusions

There are various theoretical reasons to expect private schooling to be more effective and more efficient than public schools. However, the international literature on the relative effectiveness of private schooling demonstrates that the empirical evidence of this is not altogether one-sided. It is probably fair to say that most studies find moderate positive effects of private schooling on educational achievement. The relative effectiveness of private schooling in the African and South African context remains a comparatively under-researched issue, largely due to a lack of suitable data. The analysis done in this chapter is therefore quite exploratory in nature.

This chapter found that independent schools performed better *on average* than public schools, as measured by the success rate of schools in achieving matric passes. Once SES and the level of funding per student were accounted for, the independent school advantage was no longer unambiguous, but only remained within certain parts of the school system. A potentially important finding was that amongst the historically black part of the school system, independent schools performed better than their public sector counterparts at similar levels of SES and funding per student. This finding should probably be regarded as preliminary and therefore deserving of further research. A more rigorous analysis would be made possible by the availability of data containing student characteristics. This would help ascertain whether the apparent advantage of independent schools within the historically black part of the system is attributable to differences amongst students and their backgrounds rather than superior educational processes.

This analysis can unfortunately not be certain about the underlying reasons for the apparent independent schools advantage. This is because there is no way of controlling for bias in the self-selection of students of different ability and motivation into independent schools. It is possible, for example, that highly motivated black students and those with parents who place a high value on education are likely to select themselves into the independent sector, and are also likely to perform well in school for the same reasons of motivation and home support. If this is driving the independent schools advantage within the historically black part of the system, then an expansion of the independent schools sector cannot be expected to produce an overall improvement in performance as there is a limited stock of highly motivated students and parents. The main implication for policy would then be that an increase in the commitment of parents to the education process should be pursued. However, if the performance advantage of historically black independent schools is indeed due to superior management, better educational practice or other features peculiar to independent schools then an expansion of the independent schools sector might be a viable option for policy makers, and perhaps also for private actors, such as NGO's, aiming to contribute to education in South Africa.

CHAPTER 7: SUMMARY

In one sense, this thesis was a response to the mounting evidence that the majority of South African children are attaining disturbingly low levels of cognitive achievement. The response was to ask what this means for future economic development in South Africa. Economic development was conceived of as more than economic growth, although this may be an important part of how development happens. Rather, the concept of economic development was presented as long term change that facilitates improved living standards for the whole population, especially the poor. The standard textbook understanding of economic development was thus augmented by theories of justice, in particular that of John Rawls (1971), and by the view of development as the expansion of human freedoms, as articulated by Amartya Sen (1999).

When one thinks of development in this way, it becomes apparent that one of the benefits of development has been the spread of literacy as well as broader education. Conversely, education also has great potential to contribute to development. In the economics of education literature the dominant framing story for how this occurs has been the human capital model. According to this narrative, education raises people's skills, which makes them more productive. At the level of society, greater productivity pushes out the production possibilities frontier of the economy – the stock of human capital thus constitutes one of the parameters of economic growth. At the level of the individual, improved productivity leads to higher employability, earnings and entrepreneurial potential. These attributes enhance human capability to enjoy greater freedoms and standards of living.

Since the start of the Industrial Revolution, there has been exponential growth in the absolute level of human capabilities and living standards and in their spread throughout the world. To be sure, many groups are still largely excluded from these benefits. Through accumulating human capital, the potential exists for the poor and excluded to escape poverty and join the stream of development. Yet, there is a deceptive circularity to this otherwise nice story. The home background of children, in particular their SES, significantly impacts on their educational outcomes. Although this is a universally valid observation, the strength of the relationship varies considerably across societies. The extent to which children from disadvantaged backgrounds have a real opportunity to achieve the kind of educational outcomes that are conducive to success in the labour market is one indication of whether a school system can be expected to transform existing patterns of inequality or merely reproduce them.

7.1) The effect of socio-economic status on educational achievement

Chapter 2 reviewed what is known about the influence of SES on educational outcomes, both internationally and in South Africa. There are numerous interrelated channels through which SES affects education, and these are particularly difficult to separate in South Africa. SES affects education through resources, differential educational support at home, peer effects and allocation into schools of varying quality, to mention some of the main channels.

Since the dominant influence of SES was so forcefully announced in the Coleman Report (1966), an ongoing debate has persisted about whether schools do or can in fact make a meaningful difference to the initial inequalities with which children begin school. A large body of international research has examined the effects of school and teacher characteristics on educational attainment and achievement. Characteristics like the pupil-teacher ratio, teacher education, teacher salary, per pupil expenditure, the frequency of testing and parent involvement in schools are among those most commonly associated with educational outcomes. The evidence has been mixed, however, and none of these factors has consistently been shown to improve outcomes across the majority of studies. Hanushek (2002) argues that input-based education policies around the world have failed to produce any systematic improvement in achievement. According to Hanushek, the more effective avenues for improving achievement have proven to be aspects of teacher quality that are unrelated to resources and policies that change the incentives facing teachers.

In South African studies, evidence of school and teacher effects has been fragmentary and inconsistent. To some extent, this has been due to data limitations. A number of studies have argued that management efficiency is an important, although largely unobserved, factor underlying much of the variation in school quality in South Africa. Chapter 2 also drew particular attention to the HLM methodology as a potentially valuable tool for identifying school or teacher characteristics that improve achievement and do so to a greater extent amongst low SES students. To date, however, no South African studies using HLM have identified any such characteristics.

Chapter 2 went on to expand the conceptual framework for the place of education in social mobility. A brief review of the earnings function literature, including South African studies, substantiated the point that more and better education is rewarded on the labour market. The structure of returns to education in South Africa has been shown to be convex: only at higher levels of education are the returns to additional education substantial. A sobering implication of this convexity is that unless a considerable proportion of poor children progress beyond matric, education cannot be expected to significantly reduce income inequality in South Africa.

Chapter 3 provided an empirical analysis of the influence of SES on reading achievement amongst primary school children in South Africa using the PIRLS 2006 dataset. As was the case in TIMSS 2002, the South African average score was the lowest out of all the participating countries. South Africa also exhibited the greatest variation in reading achievement. A cross country comparison of socio-economic gradients demonstrated that the changes in reading achievement associated with changes in SES were greater for South Africa than for any of the other PIRLS participants. In contrast to other countries, the relationship between SES and reading achievement in South Africa appeared non-linear and convex: the association between SES and reading scores was relatively flat at low levels of SES but steep at higher levels of SES. It was subsequently shown that the flat and steep parts of the socio-economic gradient were accounted for by two data generating processes corresponding to the two historically different sections of the South African school system. The flattish relationship between SES and achievement at low levels of SES was driven by historically black schools, while the steep part of the gradient was attributable to the pattern of achievement within historically white, coloured and Indian schools. Therefore, one can view the effect of SES on educational achievement in South Africa as having the following two dimensions: home SES is crucial in determining which "school system" one enters; then for those in the historically black system the chances of achieving high quality educational outcomes are small, regardless of home SES.

7.2) What matters in South African schools?

The second half of Chapter 3 and Chapter 4 set out to identify school and teacher characteristics that make a difference to achievement given the influence of SES. This was done mainly by estimating education production functions. Admittedly, this technique is prone to many biases and technical challenges. Education production function results should therefore be interpreted as suggestive rather than conclusive. Following the recommendation of Paul Glewwe (2002), therefore, this thesis set out to gather as much evidence as possible and then make overall conclusions based on a number of education production functions. For this reason, models were fitted using both OLS regression and HLM. Moreover, separate models were estimated for historically black schools to test whether particular school and teacher effects were simply capturing the differences between the two historically different parts of the system or actually having an impact on achievement within this group of schools.

Although the primary intention in the multivariate modelling of Chapters 3 and 4 was to identify school and teacher factors that were associated with student achievement, it was necessary to condition upon a selection of control variables and home background characteristics. To summarise the student and home variable findings from the multivariate analyses using PIRLS and the NSES, performance advantages accrued to females, children of the correct age for their grade, those from smaller households, those with books at home, those who were exposed to early literacy activities in the home prior to beginning school, those who reportedly read frequently at home and, of course, those from high SES backgrounds, as measured by household assets. Parent education (only at levels beyond matric) also had a significant effect on student achievement over and above the effect of SES.

The most important school characteristic proved to be the mean of student SES for each school. The combined SES of the school had a greater effect on the achievement of students than their own home background, although home SES is strongly deterministic of the school to which children gain access. Apart from school mean SES, there were numerous school and teacher characteristics that emerged in the multivariate analysis as important indicators of quality. These are summarised in Table 7.1. The table is organised by dividing all the variables that were significantly associated with achievement in Chapters 3 and 4 into three categories based on the strength of the relationship. Allocation into the three categories (Strong, Fair and Weak) was not based on any hard rule but on an overall subjective assessment of how consistently each variable was associated with achievement across the various models and the size of these estimated effects. The table also characterises the variables as resource variables, teacher characteristics, school organisation/leadership or teacher practice/school organisation. This characterisation contains a sense of where the responsibility lies. The table also indicates whether the estimated relationships held when analysing the full sample of South African schools, analysing historically black schools only, or in both cases. Lastly, the outcome variable and data source are specified.

Table 7.1: Summary of school and teacher characteristics that were associated with educational achievement

Variable	Strength of impact	Category	Part of school system	Outcome	Dataset
Number of maths topics	Strong[*1]	Teacher practice / school organisation	Both	Numeracy	NSES
Teacher absenteeism	Strong	Teacher practice / school organisation	Both	Literacy and Numeracy	NSES
Student absenteeism	Strong	School organisation / leadership	Both	Literacy	PIRLS
No timetable available	Strong	School organisation / leadership	Both	Literacy and Numeracy	NSES
Assessment record keeping	Fair[*2]	School organisation / leadership	Both	Numeracy	NSES
Class size	Fair	School organisation / leadership	Both	Literacy	PIRLS
Pupil teacher ratio	Fair	Resource	Both	Literacy and Numeracy	NSES
Frequency of complex maths exercises	Fair	Teacher practice / school organisation	Full sample	Numeracy	NSES
Curriculum planning using year schedule	Fair	Teacher practice / school organisation	Both	Literacy and Numeracy	NSES
Full year learning programme	Fair	Teacher practice / school organisation	Both	Literacy	NSES
Media and Communication facilities	Fair	Resource	Both	Literacy and Numeracy	NSES

[*1] A "strong" impact means that these variables were consistently associated with achievement across various model specifications and that the size of the estimated effect was substantial.

[*2] A "fair" impact means that these variables were significantly associated with achievement in several models and the size of the estimated effects was moderate.

Table 7.1 (Continued): Summary of school and teacher characteristics that were associated with educational achievement

Variable	Strength of impact	Category	Part of school system	Outcome	Dataset
Quality of LTSM inventories	Fair[*2]	School organisation / leadership	Both	Literacy	NSES
Teacher knowledge	Fair	Teacher characteristic	Both	Literacy and Numeracy	NSES
Time spent on assessment	Fair	Teacher practice / school organisation	Both	Literacy and Numeracy	NSES
Time spent teaching	Fair	Teacher practice / school organisation	Both	Literacy and Numeracy	PIRLS & NSES
Extended writing exercises	Weak[*3]	Teacher practice / school organisation	Full sample	Literacy	NSES
Frequency of homework	Weak	School organisation / leadership	Both	Literacy	PIRLS
Frequency of short word exercises	Weak	Teacher practice / school organisation	Full sample	Literacy	NSES
Full set of class texts	Weak	Resource / school organisation	Full sample	Literacy	NSES
Long sentence exercises	Weak	Teacher practice / school organisation	Full sample	Literacy	NSES
Students per classroom	Weak	Resource	Historically black	Literacy	NSES
Teacher education	Weak	Teacher characteristic	Historically black	Literacy	PIRLS
Teacher experience	Weak	Teacher characteristic	Full sample	Literacy	PIRLS

[*2] A "fair" impact means that these variables were significantly associated with achievement in some models and the size of the estimated effects was moderate.

[*3] A "weak" impact means that these variables were significantly associated with achievement in one or two models and the size of the estimated effects was small.

School resource variables were often not consistently or statistically significantly related to student achievement. For example, composite indices for school infrastructure and LTSM derived from several variables in PIRLS did not significantly predict achievement. Using the NSES data, several variables describing school facilities were tested for inclusion in the models but only an index capturing the presence and functionality of media and communication facilities warranted inclusion, and then only in some of the models. The number of students per grade 4 classroom had a small effect in one of the models restricted to historically black schools.

The pupil-teacher ratio can also be regarded as a resource variable. This was fairly consistently associated with achievement according to the models on the NSES data, although the size of the association was too small to make reducing pupil-teacher ratios an economically attractive policy option. Much more important than the presence of resources was how well they were managed. The distinction between pupil-teacher ratio and class size illustrates this. The former is simply the ratio of students to teachers, while the latter indicates how many students are actually in a class with one teacher at any point. This thesis found class size to be a more important factor than pupil-teacher ratios. Class sizes in South Africa are abnormally high and vary considerably more than pupil-ratios. This reflects differences in the way schools organise their timetable and share the burden of teaching. Reducing very large classes to a maximum of 50 students can be expected to significantly improve achievement amongst students in those schools concerned. This would not involve serious budget implications as it is primarily a matter of school management. Some form of improved monitoring and accountability may be required to promote reductions in class sizes. Apart from being concerned with the direct effects of class size, very large classes can therefore also be regarded as a good indicator of poor school management in general.

Another indicator of how well schools managed their available resources was the quality of inventories for LTSM. The quality of inventories was fairly consistently associated with student achievement. In one of the HLM models for the full sample of schools, the presence of a full set of class texts was associated with literacy achievement. This is ostensibly a resource variable, although the presence of a full set of texts may also reflect that textbooks were well looked after in those schools.

Several teacher characteristics did not appear to underlie much of the variation in student achievement. Only weak and fragmentary evidence was found linking student achievement to teacher education (positively) and teacher experience (negatively). Teacher knowledge was somewhat more consistently associated with achievement, especially in the case of mathematics. Teacher knowledge may well have come through more strongly if a more comprehensive measure were available. The NSES administered very short tests resulting in a rather crude measure of teacher knowledge. Nevertheless, this is more than what has been available up until now in other large sample surveys of South African schools. The third round of the SACMEQ project administered a teacher test, in which South African teachers also participated. When this dataset is released into the public domain an exciting opportunity for further research into the influence of teacher knowledge on student achievement in South Africa will present itself.

Aspects of teacher practice, which could be summed up as teacher work ethic, were more important than teacher education, experience or knowledge. The number of teachers absent on the day of the NSES survey proved to be consistently and strongly associated with student achievement. More time allocated by teachers to teaching and assessment indicated good teacher practice. Teachers who gave homework frequently and who ensured that students regularly completed various types of mathematics and writing exercises, obtained higher performance from their students.

The practices of individual teachers with respect to absenteeism, time management and curriculum coverage cannot be separated from the overall climate of school organisation and instructional leadership that is present. Several findings confirmed the importance of time management and planning within schools. When schools were not able to show a timetable to the fieldworker this was evidently a strong indication of a disorganised and poorly functioning school. High teacher absenteeism, although an aspect of teacher behaviour, is an outflow of weak school leadership and generally low school functionality. The same applies to class size and time spent teaching: in schools with poor time management and planning, teachers spend less time teaching and classes are consequently larger. Student achievement was fairly consistently higher in schools where curriculum planning was done using a year schedule and where teachers could show a learning programme that showed planning complete until the end of the year. This supports the contention that good time management and curriculum planning are key aspects of instructional leadership that facilitate effective curriculum coverage.

Reeves (2005, quoted in Taylor, 2007: 534) finds that learning in South African schools is directly proportional to the extent of curriculum coverage. This is confirmed by the collective evidence from several indicators of curriculum coverage that materialized from reviews of student workbooks in the NSES. The most consistent of these indicators was the number of mathematics topics that had been covered in the year. It seems obvious that if schools have covered only a small proportion of the curriculum, numeracy achievement on curriculum-based tests will be very low on average. Other indicators that were associated with student achievement in some of the models were the number of complex mathematics exercises, extended writing exercises, long sentence exercises and short word exercises. Curriculum coverage is therefore one of the important trends in Table 7.1.

The quality of assessment record keeping, time spent on assessment and the frequency of homework were all associated with student achievement and point to the role of assessment policy and practice in a school. The accuracy of assessment as a feedback mechanism to students emerged as an important aspect of school quality in Chapter 5. This chapter examined the relationship between grade 8 mathematics achievement in TIMSS 2002 and matric outcomes. It was established that grade 8 achievement was strongly deterministic of matric outcomes. For the bottom performing 20% of students in grade 8 the chances of going on to pass matric were very low. Furthermore, the negative impact of low SES was already fully evident in the ranking of achievement by grade 8. This implies that interventions to reduce the negative effects of low SES may be most effective prior to high school: in primary school and even in ECD.

The historically different sections of the school system differed in their ability to convert demonstrated ability in grade 8 into matric outcomes, as measured by passing and the total marks in matric mathematics and English. For students with the same level of grade 8 mathematics achievement, those in historically white and Indian schools had a greater probability of passing matric and achieved higher marks in mathematics and English on average than those in historically black and coloured schools. An initially surprising result was that historically black schools appeared to convert better than historically coloured schools, albeit from a very low initial level of achievement in TIMSS. To some extent this may reflect an under-utilisation of human capital in historically coloured schools, but it is unlikely to be a success story about efficiency or interventions within historically black high schools. A preferred explanation was that factors such as writing TIMSS in a language other than home language, a lack of exposure to frequent or accurate assessment and poor exam writing technique may have contributed to a systematic underestimation of the capabilities of students in historically black schools in TIMSS. If this was the case, these students may have been able to perform at a level somewhat nearer to their true ability in matric, thus creating the impression of greater improvement since grade 8.

Patterns in the selection of mathematics as a subject to take for matric were also interpreted to suggest that accurate assessment and meaningful feedback may have been lacking in the historically black system. In these schools, the distribution of grade 8 mathematics achievement for students who took mathematics in matric was virtually identical to that for those who did not ultimately take matric mathematics. Having performed very poorly in grade 8, those in historically black schools who continued with mathematics again achieved very low marks in matric, indicating that they may have had an inflated idea of their mathematics knowledge when making subject choices. Inaccurate and lenient assessment would have contributed to such an inflated idea. This suggestive evidence complements other recent research that has demonstrated weak assessment in parts of South Africa's school system.

The quality of assessment practice may also differ between independent and public schools in South Africa, as Chapter 6 suggested. In independent schools, the numbers enrolled per grade was consistent across grades 10, 11 and 12. In public schools, however, the enrolment numbers dropped substantially at grade 11 and again at grade 12. This pattern in public schools may have arisen from the combination of lenient progression in earlier grades based on inaccurate assessment and the incentive to hold back weak students created by a high stakes standardised evaluation in matric.

The comparison between the public and independent school sectors in Chapter 6 produced several key findings. Firstly, the independent sector does not consist of only elite historically privileged schools. Instead, the majority of students in the sector are black and the number of low and middle fee independent schools has grown considerably over the past two decades. Nevertheless, on average it does serve a more affluent group of students than the public schools sector. Before taking SES and the level of funding into account, independent schools performed better on average than public schools, as measured by matric pass rates. After controlling for these factors, there was no uniform independent school performance advantage. Amongst low to middle SES historically black schools, however, independent schools performed better than public schools, after controlling for the level of funding and school fees. This is a potentially important finding as it applies to the part of the school system that is highest on both the policy agenda and the agenda for economic development as conceived of in this thesis.

It is however uncertain what is driving the independent school advantage in this part of the system. It may be that superior management, better educational practice or other features peculiar to independent schools underlie this result, in which case an expansion of the independent sector could be a justified recommendation. On the other hand, it may be that highly motivated black students and those with parents who place a high value on education are likely to select themselves into the independent sector. Indeed, evidence from the Community Survey (2007) suggests that at given levels of asset-based SES, parents in the independent school sector pay higher fees than those in the public school sector. A limited stock of highly motivated students and parents could mean that an expansion of the independent sector should not be expected to lead to better educational performance. The main implication for policy would then be that an increase in the commitment of parents to the education process should be pursued. Due to data limitations the results of Chapter 6 should not be interpreted as conclusive. Yet, the findings, especially the indications of an independent school advantage within the historically black part of the system, are potentially important enough to warrant further research in this area.

To summarise these findings about what was shown to matter in South African schools, two broad factors did not appear to strongly influence achievement and six did. School resources (1) and certain teacher characteristics (2), including education, experience and knowledge, did not come through as consistent predictors of achievement. For both of these, some qualification is needed. Although additional resources do not guarantee improved outcomes, they may matter conditional upon how well they are managed and on the general functionality of the school into which they are inserted. Although there was some evidence of teacher knowledge being important, a better measure of teacher knowledge may well facilitate a clearer demonstration of its importance to student achievement.

The most important factors emerging in this thesis that affected student achievement in South African schools were the management of school resources (1), teacher work ethic (2), time management and planning within schools (3), curriculum coverage (4), the accuracy of assessment and feedback to students (5), and parent commitment to education (6). It is logical to ask what can be done to improve these aspects of schooling. This thesis has not set out to explore potential intervention strategies, yet it is worth making a few practical suggestions to inform interventions and policy aiming to address the six aforementioned areas.

7.3) Focus areas for policy interventions

Many of these school level factors ultimately come down to good school management and leadership. The most central person in this is the school principal. Therefore, policies aiming to improve the managerial skills of principals, offer them support and promote the right people occupying principal positions should be explored. The use of incentives to encourage teachers to move to rural schools is often considered and is currently implemented in South Africa, albeit in a mild form. Yet it may be more effective to select and provide incentives for people to take up principal positions in struggling schools. This could involve identifying senior teachers, deputy principals and even existing principals with experience in well-functioning schools and offering them the task of taking over as principal at a struggling school. A significant financial incentive would probably be necessary for this to work. Conversely, the Department of Education (DoE) also needs the power to remove principals in dysfunctional schools if there is evidence that the principal is constraining the school's effectiveness. The details of such interventions will need to be carefully planned, but improving school leadership must certainly be a crucial part of school reform. A focus on the development of school principals necessarily also points to the need to improve the effectiveness of those structures on which school leadership depends, especially the functioning of school governance and departmental support to schools at local and district levels.

Ways to increase parent commitment to education, parent involvement in school life and the sense of accountability felt by teachers towards parents also need to be explored. One existing forum for this is the SGB. In terms of the South African Schools Act (1996), the principal and teachers (constituting professional management) are accountable to the SGB, which represents the governance of the school. A major obstacle to SGBs fulfilling their intended mandate and to extending their scope is a lack of capacity amongst parents in many poor and rural areas. The use of SGBs to improve accountability and parent involvement may therefore be limited to capacity building and support for SGBs or it might involve a more explicit monitoring function for SGBs. The management of school finances is one key area in which many SGBs require assistance (Mestry, 2004; Van Wyk, 2004). According to the South African Schools Act, the SGB may delegate certain financial tasks to the professional management but remains ultimately responsible (Mestry, 2004: 131-132). This is clearly an area in which greater accountability and efficiency could be achieved if SGBs had the capacity to take greater control. Although there are conflicting views about the appropriate role of SGBs in South Africa, the legislative framework exists for this to be a potentially fruitful arena for interventions.

Another way to improve accountability to parents and to address the problems around assessment will be to introduce standardised assessments prior to matric. Encouragingly, a Ministerial Committee recently reviewed the implementation of the National Curriculum Statement and recommended standardised assessments in grades 3, 6 and 9 (South Africa, 2009b). To be most effective, such standardised assessments should have several characteristics. Firstly, they should be administered within primary schools to at least one but preferably two grades, as the Ministerial Report recommends. At this stage there is little transparency regarding the quality of primary schools and many parents are under the impression that a high rate of grade progression is an indicator that all is well. Secondly, within each school, the results of the assessments should provide reliable feedback to students of their academic progress. Thirdly, the results should serve as a signal to parents of the standards being achieved within their child's school relative to other schools in the area. School-level results should, therefore, be easily accessible to parents and be well publicised. This ought to strengthen the accountability of schools to parents and generate higher parent involvement. Fourthly, the results should indicate to the DoE which schools are performing well or poorly, given their geographic and socio-economic context. Tracking the performance of schools over time could be used to alert the DoE to schools in which standards are very low or are slipping and which may be in need of new leadership.

Lastly, in order to improve curriculum coverage it is proposed that greater use of textbooks, or at least workbooks containing exercises for the full curriculum, be encouraged amongst teachers. One of the effects of outcomes based education was to discourage reliance on textbooks. Although much of the thinking behind OBE was perhaps attractive in theory, in practice it has led to inadequate curriculum coverage, as the evidence presented in this thesis has demonstrated. Along with communicating the importance of textbooks to teachers and improving the provision of textbooks and other LTSM, it may be necessary to assist schools with how to manage these resources.

7.4) Conclusion

This thesis has added to the weight of evidence that a large section of the South African school system, in which most of the country's poor and historically disadvantaged children are located, is performing very weakly. This is likely to constrain the economic development of South Africa in important ways. Interventions that aim to improve educational outcomes, such as raising the number of mathematics and science matric passes, in moderately and well-performing schools will serve to ameliorate the skills shortages that constrain economic growth. Providing opportunities for children from disadvantaged backgrounds to attend elite schools will certainly make a difference to the individuals concerned. Yet, these worthy interventions cannot be expected to alter substantially the systemic problem that for poor children the prospects are unacceptably low of achieving well enough at school to enable them to be successful in the labour market. It is therefore imperative for mobility and social transformation in South Africa that ongoing attention be given to raising the standards of teaching and learning in the large and struggling part of the school system.

Finally, although the influence of SES is particularly strong in South Africa, there is evidence to suggest that children in other Southern African countries have been performing better than equally poor South African children. This is reason to believe that improvements in the South African system must be possible, despite the influence of SES. This thesis has highlighted several key areas on which attempts to improve South Africa's schools should focus. These include the management of school resources, teacher work ethic, time management and planning within schools, curriculum coverage, the accuracy of assessment and feedback to students, and parent commitment to education. These are not necessarily the only important areas but are those that have most clearly emerged as a result of the particular research strategies, methodologies and data used in this thesis. One of the frustrating realities to those concerned with education in South Africa is that no magic bullet solutions appear to be forthcoming. Change in education, as in economic development, is likely to take time and to follow from incremental improvements which must nevertheless be pursued with clarity of purpose, urgency and enduring commitment.

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Appendix A: Mean reading achievement by country in PIRLS 2006

Table A.1: Descriptive statistics of reading achievement in PIRLS 2006 by country

Country	Reading overall						Reading purposes	
	Mean (All)	Std error of mean	Std Dev. (All)	Mean (Boys)	Mean (Girls)	Diff: (Boys – Girls)	Mean: Literary	Mean: Informational
Austria	538	2.2	64	533	543	10	537	536
Belgium (Flemish)	547	2.0	56	544	550	6	544	547
Belgium (French)	500	2.6	69	497	502	5	499	498
Bulgaria	547	4.4	83	537	558	21	542	550
Canada, Alberta	560	2.4	68	556	564	8	561	556
Canada, British Columbia	558	2.6	69	554	562	9	559	554
Canada, Nova Scotia	542	2.2	76	531	553	21	543	539
Canada, Ontario	555	2.7	71	549	562	13	555	552
Canada, Quebec	533	2.8	63	527	539	13	529	533
Chinese Taipei	535	2.0	64	529	542	13	530	538
Denmark	546	2.3	70	539	553	14	547	542
England	539	2.6	87	530	549	19	539	537
France	522	2.1	67	516	527	11	516	526
Georgia	471	3.1	75	463	480	17	476	465
Germany	548	2.2	67	544	551	7	549	544
Hong Kong	564	2.4	59	559	569	10	557	568
Hungary	551	3.0	70	548	554	5	557	541
Iceland	511	1.3	68	501	520	19	514	505
Indonesia	405	4.1	79	395	415	20	397	418
Iran	421	3.1	95	414	429	14	426	420
Israel	512	3.3	99	506	520	15	516	507
Italy	551	2.9	68	548	555	7	551	549
Kuwait	330	4.2	111	297	364	67	340	327
Latvia	541	2.3	63	530	553	23	539	540
Lithuania	537	1.6	57	528	546	18	542	530
Luxembourg	557	1.1	66	556	559	3	555	557
Macedonia	442	4.1	101	432	453	21	439	450
Moldova	500	3.0	69	493	507	14	492	508
Morocco	323	5.9	109	314	332	18	317	335
Netherlands	547	1.5	53	543	551	7	545	548
New Zealand	532	2.0	87	520	544	24	527	534
Norway	498	2.6	67	489	508	19	501	494
Poland	519	2.4	75	511	528	17	523	515
Qatar	353	1.1	96	335	372	37	358	356
Romania	489	5.0	91	483	497	14	493	487
Russian Federation	565	3.4	69	557	572	15	561	564
Scotland	527	2.8	80	516	538	22	527	527
Singapore	558	2.9	77	550	567	17	552	563
Slovak Republic	531	2.8	74	525	537	11	533	527
Slovenia	522	2.1	71	512	532	19	519	523
South Africa	302	5.6	136	283	319	36	299	316
Spain	513	2.5	71	511	515	4	516	508
Sweden	549	2.3	64	541	559	18	546	549

Table A.1 (continued)

Trinidad & Tobago	436	4.9	103	420	451	31	434	440
United States	540	3.5	74	535	545	10	541	537
International average*	500			492	509	17	500	501
High-income*	515			507	523	17	515	514
Upper middle-income	509			500	518	18	510	508
Lower middle-income	427			419	436	17	425	433

Note: the international average, high-income average, upper middle-income average and the lower middle-income average are simply the (unweighted) mean of the (weighted) mean reading score of the countries.

* The five Canadian provinces are excluded and the two Belgium education systems are treated as two separate countries when the international and high-income countries' average are calculated.

Appendix B: Kernel Density Curves

A kernel density estimate is a non-parametric estimator, i.e. there is no fixed functional form and every data point feeds into the estimate. Kernel density curves represent an improvement on histograms, which are the simplest type of non-parametric density estimates.

In constructing a histogram, the data is divided into equal intervals called bins. Each time a data point falls within a particular interval a box is placed on top of that bin, increasing its height. There are three main disadvantages to histograms: they are not smooth; they depend on the width of the bins; and they depend crucially on the end points of the bins. A kernel density curve offers a solution to these disadvantages.

Kernel estimators centre a kernel function at each data point, thus overcoming the dependence on the bin endpoints. In the analysis in this thesis, the commonly used Gaussian kernel function was applied. A kernel density curve connects kernel estimates of the density of an outcome at each point across its distribution, smoothing over the contribution of each data point relative to its local neighbourhood. The extent of the smoothing depends on the bandwidth chosen. Undersmoothing will occur when the chosen bandwidth is too narrow. Conversely, oversmoothing will occur when the chosen bandwidth is too wide, resulting in a loss of important trends in the data. The methods that can be used to determine the optimal bandwidth are not discussed here. The present analysis followed the procedure used in *Stata* to calculate the optimal bandwidth, i.e. the width that minimizes the mean integrated squared error.

Appendix C: A note on the use of parent's education in deriving an index for SES

The educational attainment of parents is generally considered to be one of the best proxies for SES. Although PIRLS is useful in that it collected information on parent's education, including this variable in the SES index presents some methodological challenges.

The educational attainment of parent's education as collected in PIRLS is an ordinal categorical variable. In the case of South Africa there were six categories:

1) 0-9 years schooling
2) complete grade 9
3) complete matric
4) post secondary training (vocational training)
5) first degree (diploma)
6) Honours/Masters/PhD degree

In Principal Component Analysis (PCA) an ordinal categorical variable such as this will be interpreted as if it were a continuous variable. One solution that has been suggested is to recode such variables into a number of binary variables entering them as separate dummies into the PCA (eg. Filmer and Pritchett, 2001 and Vyas and Kumaranayake, 2006). However, an important objection to this procedure is made by Kolenikov and Angeles (2004). They point out that such dummies will necessarily be negatively correlated with each other. This will "confuse" the PCA as to whether most of the common variation amongst the variables is caused by the correlation amongst the dummies due to the coding technique or by the unobserved factor, such as SES, which is what one aims to isolate with PCA (Kolenikov and Angeles, 2004: 5).

Kolenikov and Angeles (2004) then test various methods of including ordinal categorical variables in PCA by simulating data and testing how closely each method corresponds to the "true" values. They come out in opposition of using dummy variables and suggest that the results will be less biased if such variables are entered simply in their ordinal form. They suggest that the coding of the categories should be evenly spaced so as to avoid unnecessary bias.

Following this recommendation, the parent education variable was recoded into a pseudo continuous variable by estimating the midpoint of the years of education corresponding to each category. In the case of South Africa, the following midpoints were estimated as years of education:

1)	0-9 years schooling	4 years
2)	complete grade 9	9 years
3)	complete matric	12 years
4)	post secondary training (vocational training)	14 years
5)	first degree (diploma)	15 years
6)	Honours/Masters/PhD degree	16 years

Appendix D: Comparison of PIRLS, SACMEQ and TIMSS

Table A.2: General information on the South African TIMSS, SACMEQ II and PIRLS data

	TIMSS1995	TIMSS1999	TIMSS2002	SACMEQ II	PIRLS2006
GENERAL INFORMATION					
Year of survey	1995	1998	2002	2000	2005
Grade of pupils	Gr 7 – 8	Gr 8	Gr 8	Gr 6	Gr 5
Expected birth year of pupils	1981 / 1982	1984	1988	1988	1994
Number of pupils	9 792*	8 146	8 952	3 163	14 657
Number of schools	234	194	255	169	397
OWNERSHIP OF ITEMS/ASSETS					
Possession items for SES	*Total: 16* Calculator Computer Study desk/table Dictionary Electricity Tap water Warm water Radio TV VCR Tape recorder CD player Own room Bicycle Flush toilet Motor car	*Total: 14* Calculator Computer Study desk/table Dictionary Electricity Tap water TV VCR CD player Radio Own room Flush toilet Motor car Bicycle	*Total: 16* Calculator Computer Study desk/table Dictionary Electricity Tap water TV VCR CD player Radio Own room Flush toilet Motor car Bicycle Telephone Fridge	*Total: 14* Newspaper Magazine Radio TV VCR Cassette player Telephone Refrigerator Car Motorcycle Bicycle Piped water Electricity Table to write on	*Total: 10* Computer Study desk/table Own books Newspaper Own room Own cellphone Calculator Dictionary Electricity Tap water
No. of students specifying answers on ALL items	8 055 (82.26%)	7 012 (86.08%)	7 066 (78.93%)	3 163 (100.00%)	11 023 (75.21%)
MEAN SCORE					
Reading/Language	n/a	n/a	n/a	492	302
Maths	276	275	264	486	n/a
Science	260	243	244	n/a	n/a

* The number of Grade 7 and Grade 8 students are 5,301 and 4,491 respectively.

Appendix E: Lowess smoothing regression

Robust locally weighted regression or lowess regression is a method used to smooth scatterplots and was developed by William Cleveland and others. The smoothed value at X_i is attained by applying weighted least squares regression to the data (X values against Y values) where the weight is greater if X_k is close to X_i and smaller if X_k is further from X_i (Cleveland, 1979: 829). The advantage of having locally weighted smoothing is that what happens on the left of a scatterplot does not affect the fitted values on the far right, in contrast to linear or polynomial smoothing methods (Statacorp, 1997: 297).

Appendix F: Description of variables used in multivariate analysis of PIRLS data

Table A.3: Student level variables (Student questionnaire)

Variable name	Description	Weighted mean
SES	Z-score index of socio-economic status: Min = 0, std dev = 1	1.76
Under 11	Dummy variable: Younger than 11 years	0.42
Age 11	Dummy variable: Expected age at grade 5: 11 years	0.51
Over 11	Dummy variable: Older than 11 years	0.05
Female	Dummy variable: gender is female; reference category is male	0.52
Speak language of test	Dummy variable: student speaks the language of the test at home "sometimes" or "always". Reference category is "never".	0.73
Homework more	Dummy variable: Student receives homework at least once a week.	0.54
Homework less	Dummy variable: Student receives homework less than once a week.	0.10
Homework never	Dummy variable: Student never receives homework	0.18
Help unnecessary	Dummy variable: Student reports that they do not need help with homework	0.11
Help from parent	Dummy variable: Student receives help with homework from a parent	0.21
No help available	Dummy variable: No help from a parent is available.	0.48
Feel safe at school	Dummy variable: Student feels safe at school. Reference category : Student does not feel safe.	0.22
Visit library weekly	Dummy variable: Student visits a (non-school) library on a weekly basis.	0.29
Visit library sometimes	Dummy variable: Student visits a (non-school) library less often than every week.	0.36
Visit library never	Dummy variable: Student never visits a (non-school) library.	0.20
More than 10 books	Dummy variable: There are more than 10 books present at student's home. Reference category: Fewer than 10 books present at home.	0.41

Table A.4: Home level variables (Home questionnaire)

Variable name	Description	Weighted mean
Full-time job	Dummy variable: At least one parent has a full time job	0.33
Early literacy: high	Dummy variable based on index of early literacy activities in the home	0.41
Early literacy: medium	Dummy variable based on index of early literacy activities in the home	0.34
Early literacy: low	Dummy variable based on index of early literacy activities in the home	0.09
Parent less than matric	Dummy variable: Highest educational attainment of either parent is less than matric	0.31
Parent matric only	Dummy variable: Highest educational attainment of either parent is matric	0.69
Parent beyond matric	Dummy variable: Highest educational attainment of either parent is higher than matric	0.19

Table A.5: Teacher level variables (Teacher questionnaire)

Variable name	Description	Weighted mean[93]
Class size	Number of students in the class	41.75
Teacher experience 0 to 3	Dummy variable: less than 3 years of teaching experience	0.06
Teacher experience 4 to 7	Dummy variable: Between 4 and 7 years of teaching experience	0.08
Teacher experience 8 to 12	Dummy variable: Between 8 and 12 years of teaching experience	0.26
Teacher experience 13 to 19	Dummy variable: Between 13 and 19 years of teaching experience	0.27
Teacher experience 20 plus	Dummy variable: more than 20 years of teaching experience	0.28
Teacher has degree	Dummy variable: Teacher has a degree; Reference category is no degree.	0.12
Time spent teaching > 50%	Dummy variable: Teacher reports spending more than 50% of the available school hours on teaching. Reference category: Less than 50% of available time is spent teaching.	0.29

[93] This is the mean amongst students rather than amongst schools.

Table A.6: School level variables (Principal questionnaire)

Variable name	Description	Weighted mean[94]
School mean SES	Mean of student SES within each school: Min = 0, std dev = 1	3.04
Afrikaans	Dummy variable: School took the test in Afrikaans	0.10
English	Dummy variable: School took the test in English	0.24
Rural	Dummy variable: School is located in a rural area	0.61
Absenteeism: low	Dummy variable: Principal regards student absenteeism as a negligible problem	0.12
Absenteeism: moderate	Dummy variable: Principal regards student absenteeism as a moderate problem	0.42
Absenteeism: severe	Dummy variable: Principal regards student absenteeism as a severe problem	0.45
LTSM shortage: minor	Dummy variable derived from summative index based on various questions regarding the presence and state of Learning Support Materials (LTSM)	0.42
LTSM shortage: moderate	Dummy variable derived from summative index based on various questions regarding the presence and state of Learning Support Materials (LTSM)	0.30
LTSM shortage: severe	Dummy variable derived from summative index based on various questions regarding the presence and state of Learning Support Materials (LTSM)	0.24
Infrastructure shortage: minor	Dummy variable derived from summative index based on various questions regarding the presence and state of school infrastructure	0.39
Infrastructure shortage: moderate	Dummy variable derived from summative index based on various questions regarding the presence and state of school infrastructure	0.33
Infrastructure shortage: severe	Dummy variable derived from summative index based on various questions regarding the presence and state of school infrastructure	0.24

Note: In the above tables, where the means of a set of dummy variables does not add up to 1, this is due to non-response.

[94] This is the mean amongst students rather than amongst schools.

Appendix G: Multivariate models for PIRLS not shown in Chapter 3

Table A.7: OLS models for the full sample of South African students in PIRLS

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Student-level variables							
SES	59.53***	-22.37**	-28.62***	-8.46	-12.36~	-12.88*	-2.35
	(4.52)	(7.76)	(6.44)	(5.69)	(6.43)	(5.85)	(3.95)
SES squared		24.81***	19.79***	12.94***	17.01***	12.14***	3.28**
		(2.94)	(2.19)	(1.87)	(2.21)	(1.81)	(1.16)
Under 11			-45.02***	-41.73***	-50.30***	-33.85***	-26.81***
			(3.27)	(2.93)	(3.61)	(2.80)	(2.55)
Over 11			-54.23***	-55.64***	-58.28***	-40.24***	-33.83***
			(5.90)	(5.24)	(6.66)	(5.07)	(4.55)
Female			22.52***	27.15***	27.44***	28.04***	27.13***
			(2.53)	(2.36)	(2.80)	(2.14)	(1.82)
Western Cape			81.60***	86.77***	86.44***	30.62~	22.26*
			(17.82)	(15.90)	(19.28)	(18.11)	(11.00)
Northern Cape			62.89***	62.31***	54.32**	-9.93	0.30
			(16.50)	(15.04)	(20.10)	(20.68)	(13.74)
Free State			54.06***	42.48***	48.28***	25.15~	43.33***
			(11.31)	(11.90)	(14.09)	(14.18)	(11.80)
KwaZulu-Natal			44.39***	54.16***	49.96***	50.03***	45.37***
			(12.79)	(11.53)	(14.23)	(11.06)	(8.85)
North West Province			30.30*	30.88*	28.80~	30.37*	31.14**
			(14.61)	(14.90)	(16.68)	(13.30)	(11.83)
Gauteng			55.99***	46.67**	53.14**	13.68	16.39
			(16.32)	(14.86)	(18.33)	(15.91)	(12.62)
Mpumalanga			4.65	7.20	4.08	2.87	7.85
			(12.64)	(11.39)	(16.08)	(13.85)	(11.50)
Limpopo			5.03	-6.39	0.64	7.25	15.71~
			(10.35)	(10.56)	(12.41)	(11.06)	(8.87)
Speak language of test			40.66***				33.38***
			(4.25)				(3.87)
Speak unspecified			14.81*				16.53***
			(5.96)				(4.87)

Table A.7 (continued)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Homework more			22.46***				15.49***
			(3.82)				(2.88)
Homework less			30.73***				12.96**
			(5.84)				(4.27)
Homework unspecified			1.85				-3.62
			(5.66)				(4.44)
Help unnecessary			41.90***				16.66***
			(4.84)				(3.29)
Help from parent			29.36***				9.34***
			(3.83)				(2.63)
Help unspecified			8.65				-6.27
			(5.44)				(4.35)
Feel safe at school			22.71***				18.67***
			(3.33)				(2.40)
Safety unspecified			4.81				-2.87
			(5.91)				(5.43)
Visit library weekly			16.82***				
			(5.06)				
Visit library sometimes			1.68				
			(4.00)				
Library visits unspecified			-4.42				
			(7.96)				
More than 10 books			23.07***				
			(4.84)				
Books at home unspecified			-7.58				
			(4.75)				
Home-level variables							
Full-time job				39.78***			18.64***
				(3.49)			(2.36)
Early literacy: high				14.49***			13.86***
				(4.20)			(3.51)
Early literacy: medium				3.86			6.14~
				(3.74)			(3.42)

Table A.7 (continued)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Early literacy unspecified				11.69*			3.83
				(5.71)			(4.36)
Parent matric only				6.19			1.74
				(4.81)			(4.13)
Parent beyond matric				92.70***			38.90***
				(9.71)			(7.06)
<u>Teacher-level variables</u>							
Class size					-3.429***		-1.375*
					(0.970)		(0.600)
Class size squared					0.022**		0.010*
					(0.008)		(0.005)
Teacher experience 4 to 7					-12.46		-18.33
					(16.28)		(12.45)
Teacher experience 8 to 12					-27.41~		-13.97
					(14.07)		(11.36)
Teacher experience 13 to 19					-30.43*		-21.66*
					(12.98)		(10.20)
Teacher experience 20 plus					-14.40		-23.75*
					(13.88)		(10.32)
Teacher experience unspecified					-41.08~		-27.14*
					(24.14)		(13.05)
Teacher has degree					24.82~		
					(13.88)		
Teacher degree unspecified					-18.47~		
					(9.60)		
Time spent teaching > 50%					20.36~		
					(10.66)		
Time teaching unspecified					-0.82		
					(13.13)		
<u>School-level variables</u>							
Afrikaans						107.93***	74.48***
						(14.29)	(9.52)
English						73.02***	30.13**
						(12.07)	(9.50)

Table A.7 (continued)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Rural						-40.58***	-18.13*
						(10.20)	(8.54)
Rural unspecified						-39.08	-20.68
						(33.49)	(15.34)
Absenteeism: moderate						-37.48**	-10.03
						(13.43)	(8.30)
Absenteeism: severe						-60.88***	-15.41~
						(12.47)	(7.90)
Absenteeism unspecified						-67.40**	-9.09
						(25.82)	(19.11)
LTSM shortage: moderate						-9.95	
						(8.74)	
LTSM shortage: severe						-6.43	
						(9.19)	
LTSM shortage unspecified						23.07	
						(18.69)	
Infrastructure shortage: moderate						-14.50	
						(8.90)	
Infrastructure shortage: severe						-20.52*	
						(9.52)	
Infrastructure shortage: unspecified						-42.34*	
						(21.32)	
School mean SES							-39.17***
							(10.20)
School mean SES squared							12.37***
							(1.89)
Constant	199.76***	241.29***	172.57***	198.38***	348.10***	315.07***	258.95***
	(5.49)	(5.41)	(9.56)	(8.70)	(28.74)	(17.77)	(24.12)
R-squared	0.2226	0.2645	0.4641	0.4909	0.4321	0.5288	0.6483
N	14279	14279	14279	14279	13342	14279	13342

Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

Table A.8: Separate OLS models for the historically different parts of the school system

	[1] Full SA sample		[2] African language		[3] Afr/English language	
Student-level variables						
SES	-2.35	(3.95)	6.25***	(1.26)	9.93***	(2.70)
SES squared	3.28**	(1.16)				
Under 11	-26.81***	(2.55)	-18.98***	(2.17)	-40.23***	(4.67)
Over 11	-33.83***	(4.55)	-26.16***	(4.27)	-42.24***	(11.44)
Female	27.13***	(1.82)	30.51***	(2.02)	20.05***	(3.65)
Western Cape	22.26*	(11.00)	17.96	(18.49)	76.89***	(14.51)
Northern Cape	0.30	(13.74)	Dropped: low sample size		55.47**	(17.42)
Free State	43.33***	(11.80)	75.64***	(12.19)	48.35	(37.95)
KwaZulu-Natal	45.37***	(8.85)	40.32***	(8.05)	82.84***	(15.08)
North West Province	31.14**	(11.83)	52.27***	(13.30)	71.99	(43.32)
Gauteng	16.39	(12.62)	27.05*	(12.33)	78.76***	(15.92)
Mpumalanga	7.85	(11.50)	24.96*	(10.19)	43.27**	(13.63)
Limpopo	15.71~	(8.87)	26.11**	(8.66)	Dropped: low sample size	
Speak language of test	33.38***	(3.87)	25.29***	(3.99)	52.46***	(10.91)
Speak unspecified	16.53***	(4.87)	17.80***	(4.40)	22.58*	(10.81)
Homework more	15.49***	(2.88)	13.50***	(2.74)		
Homework less	12.96**	(4.27)	3.62	(4.26)		
Homework unspecified	-3.62	(4.44)	-7.06	(4.88)		
Help unnecessary	16.66***	(3.29)	2.93	(3.61)	25.84***	(5.12)
Help from parent	9.34***	(2.63)	5.63~	(2.92)	9.29*	(4.50)
Help unspecified	-6.27	(4.35)	-8.15~	(4.73)	-7.29	(9.02)
More than 10 books					9.35*	(4.52)
Books at home unspecified					-24.70***	(6.99)
Feel safe at school	18.67***	(2.40)	15.99***	(2.44)	8.59~	(4.49)
Safety unspecified	-2.87	(5.43)	-7.59	(5.19)	-14.39	(10.00)
Home-level variables						
Full-time job	18.64***	(2.36)	14.58***	(2.44)	19.03***	(4.31)
Early literacy: high	13.86***	(3.51)			23.12**	(7.42)
Early literacy: med	6.14~	(3.42)			3.56	(7.79)
Early literacy unspecified	3.83	(4.36)			9.73	(8.53)
Parent matric only	1.74	(4.13)	-0.76	(2.35)	1.72	(5.33)
Parent beyond matric	38.90***	(7.06)	20.62***	(3.77)	36.28***	(6.83)
Teacher-level variables						
Class size	-1.37*	(0.60)	-1.19***	(0.27)	11.72***	(1.47)
Class size squared	0.01*	(0.00)	0.01***	(0.00)	-0.20***	(0.02)
Teacher experience 4 to 7	-18.33	(12.45)	-0.19	(5.34)		
Teacher experience 8 to 12	-13.97	(11.36)	-15.14***	(4.53)	1.76	(7.48)
Teacher experience 13 - 19	-21.66*	(10.20)	-20.07***	(4.42)	-33.28***	(6.49)
Teacher experience 20 plus	-23.75*	(10.32)	-27.30***	(4.40)	-16.79**	(5.66)
Teacher experience unsp.	-27.14*	(13.05)	-34.30*	(16.16)	19.36	(43.11)
Teacher has degree			11.43**	(3.71)	20.26	(16.70)
Teacher degree unspecified			6.20	(6.76)		

Table A.8 (continued)

	[1] Full SA sample		[2] African language		[3] Afr/English language	
School-level variables						
Afrikaans	74.48***	(9.52)				
English	30.13**	(9.50)				
Rural	-18.13*	(8.54)	-12.30***	(2.87)		
Rural unspecified	-20.68	(15.34)	-22.79	(19.62)		
Absenteeism: moderate	-10.03	(8.30)	-16.30***	(3.83)	-14.53**	(5.55)
Absenteeism: severe	-15.41~	(7.90)	-21.71***	(3.89)	-38.81***	(6.51)
Absenteeism unspecified	-9.09	(19.11)	-4.48	(18.42)	Dropped: low sample size	
School SES	-39.17***	(10.20)	7.74***	(1.68)	46.86***	(3.49)
School SES squared	12.37***	(1.89)				
Constant	258.95***	(24.12)	231.23***	(10.71)	-69.03*	(33.23)
Sample size	13342		9185		2412	
R-squared	0.65		0.26		0.68	

Table Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

In Column [3] the reference category for teacher experience included teachers with 0 to 3 years and those with 4 to 7 years due to the small number of teachers with 0 to 3 years in this group of schools.

Table A.9: Full HLM model for Reading achievement in PIRLS

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	301.75***
School mean SES	37.12***
Class size	-0.59*
Test in Afrikaans	81.77***
Test in English	55.19***
Rural	-33.42**
Rural unspecified	-12.00
Teacher experience 4 to 7	-12.75
Teacher experience 8 to 12	-7.41
Teacher experience 13 to 19	-31.61*
Teacher experience 20 plus	-22.91
The student SES achievement slope, β_1	
Intercept	9.18***
School mean SES	3.22*
Class size	-0.12~
Rural	-5.52*
Rural unspecified	-2.95
Under age (<11)	-25.08***
Over age (>11)	-20.67***
Female	28.81***
Speak the language of test at home	31.59***
Speak the language: unspecified	17.51***
Homework less than once a week	7.23~
Homework more than once a week	13.77***
Homework frequency: unspecified	-8.64*
Help at home unnecessary	9.45**
Help from parent	3.81
Help unspecified	-8.79*
Feel safe at school	11.27***
Safety unspecified	-5.78
Early literacy activities: high, β_{14}	
Intercept	10.32**
School mean SES	4.73**
Time spent teaching > 50%	9.26*
Time spent teaching unspecified	9.44
Early literacy activities: medium	0.01
Early literacy unspecified	-1.20
A Parent has matric only	-2.88
Parent education beyond matric	24.26***
Parent has fulltime job	13.05***

Random effects	**Variance Components**
Intercept, $\mu 0j$	2671.35***
Student SES slope, $\mu 1j$	18.24**
Early literacy activities slope, $\mu 14j$	25.01~
Level-1 error, rij (σ^2)	4246.30

Table Notes:

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Only the student SES achievement slope and the high early literacy activities achievement gap were allowed to vary between schools and were group-mean centred.

The model controlled for non-response regarding whether the language of the test was spoken at home, frequency of homework, availability of help with homework, early home literacy activities, the number of library books at schools and the urbanicity of schools.

Rho value (ICC) = 0.67
Proportion of within-school variance explained by the model = 0.18
Proportion of between-school variance in β_0 explained by the model = 0.74
Proportion of between-school variance in β_1 explained by the model = 0.58
Proportion of between-school variance in β_{14} explained by the model = 0.67

Table A.10: HLM model for African language schools only

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	253.41***
School mean SES	15.99***
Rural	-20.72**
Rural unspecified	8.18
Teacher experience 4 to 7	-3.46
Teacher experience 8 to 12	-27.87*
Teacher experience 13 to 19	-31.00*
Teacher experience 20 plus	-33.89**
Teacher experience unspecified	-39.84***
The student SES achievement slope, β_1	
Intercept	6.11***
School mean SES	2.27
Class size	-0.13*
Under age (<11)	-22.01***
Over age (>11)	-19.98***
Female	31.86***
Speak the language of test at home	27.69***
Speak the language: unspecified	17.02***
Homework less than once a week	1.43
Homework more than once a week	11.91***
Homework frequency: unspecified	-16.80***
Feel safe at school	10.26***
Safety unspecified	-7.71~
A Parent has matric only	-4.26
Parent education beyond matric	19.82***
Parent has fulltime job	11.13***

Random effects	**Variance Components**
Intercept, $\mu 0j$	1703.87***
Student SES slope, $\mu 1j$	7.60~
Level-1 error, rij (σ^2)	4002.94

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Note: Only the student SES achievement slope was allowed to vary between schools and was group-mean centered.

Rho value (ICC) = 0.34
Proportion of within-school variance explained by the model = 0.16
Proportion of between-school variance in β_0 explained by the model = 0.30
Proportion of between-school variance in β_1 explained by the model = 0.19

Table A.11: HLM model for Afrikaans and English schools only

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	420.98***
School mean SES	59.69***
Class size	-2.66***
Library books: 250-5000	7.73
Library books: >5000	34.51*
The student SES achievement slope, β_1	
Intercept	13.44***
Teacher has degree	28.94***
Rural	-12.85**
Under age (<11)	-42.30***
Over age (>11)	-37.57***
Female	21.06***
Speak the language of test at home	37.28***
Speak the language: unspecified	18.63*
Help at home unnecessary	24.75**
Help from parent	10.19**
Help unspecified	-15.83**
More than ten books at home	7.53*
Books at home unspecified	-25.75***
Early literacy activities: high	22.42***
Early literacy activities: medium	1.57
Early literacy unspecified	7.45
A Parent has matric only	7.43
Parent education beyond matric	36.63***
Parent has fulltime job	17.33***

Random effects	**Variance Components**
Intercept, $\mu 0j$	1709.54***
Student SES slope, $\mu 1j$	21.90~
Level-1 error, rij (σ^2)	4841.94

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Note: Only the student SES achievement slope was allowed to vary between schools and was group-mean centered.

Rho value (ICC) = 0.66
Proportion of within-school variance explained by the model = 0.25
Proportion of between-school variance in β_0 explained by the model = 0.87
Proportion of between-school variance in β_1 explained by the model = 0.80

Appendix H: Box plots of literacy and numeracy scores in the NSES by home language

Figure A.1: Literacy scores by home language

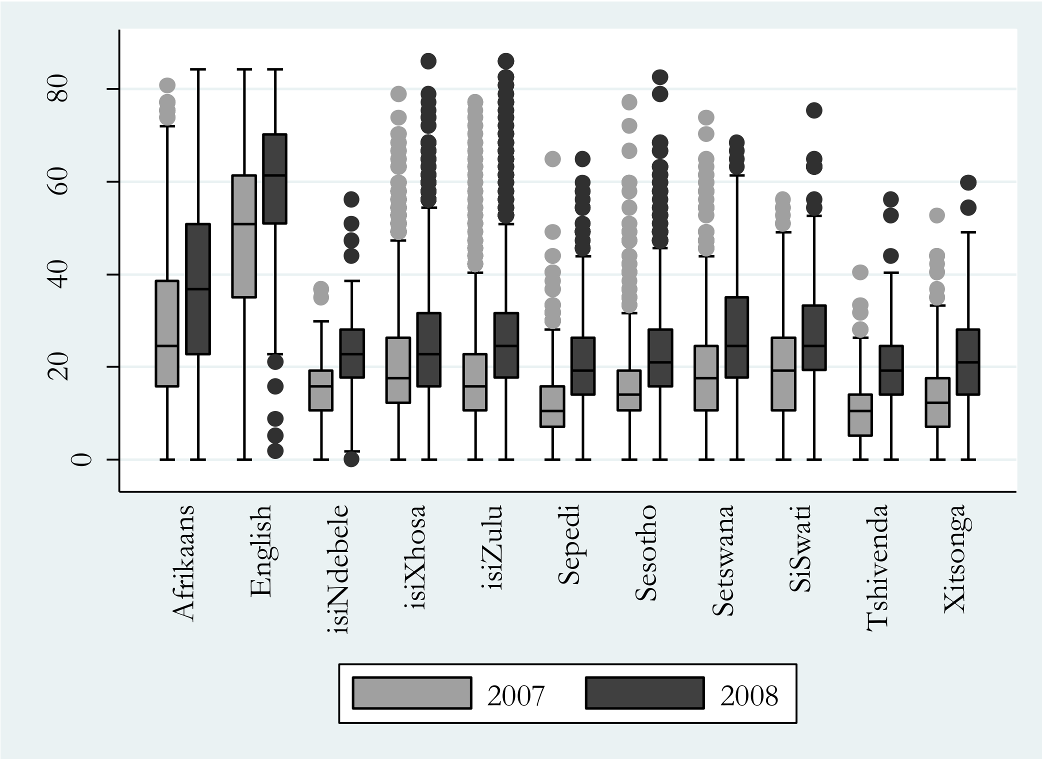
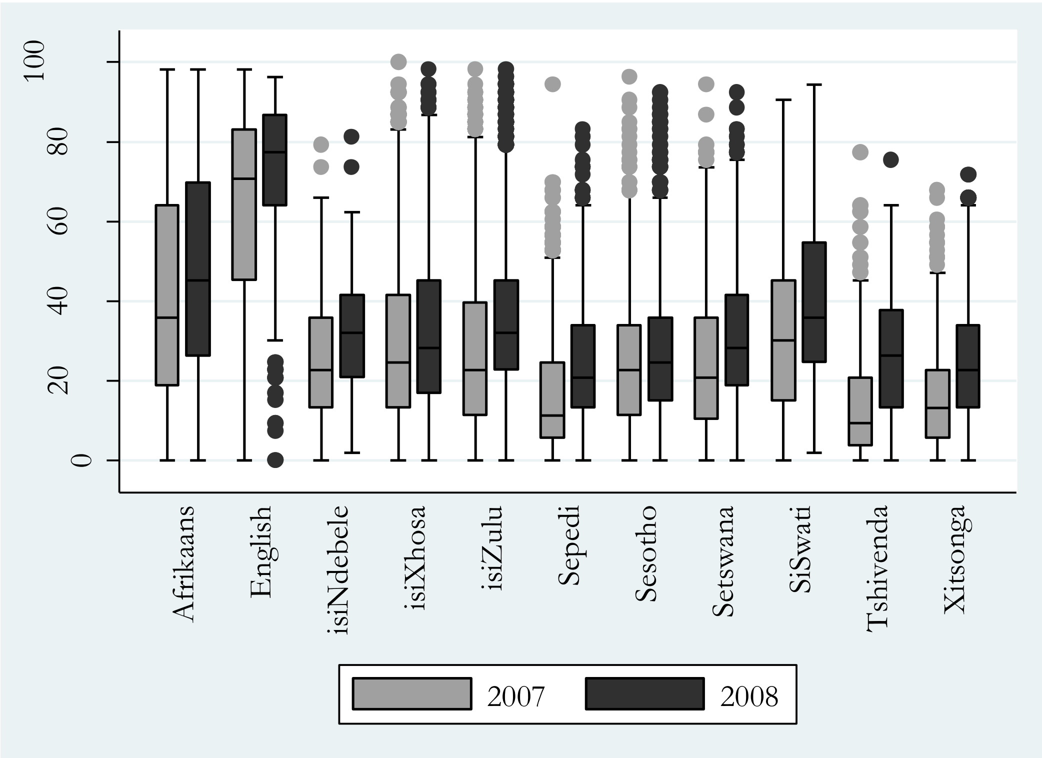


Figure A.2: Numeracy scores by home language



Appendix I: Description of variables used in multivariate analysis of NSES data

Table A.12: Student level variables (Student questionnaires of 2007 and 2008)

Variable name	Description	Weighted mean[95]
Student SES	Z-score index of socio-economic status: Min = 0, std dev = 1	1.80
Male	Dummy variable: gender is male; reference category is female	0.48
Young	Dummy variable: Younger than 10 years	0.20
Age 10	Dummy variable: Expected age at grade 4: 10 years	0.42
Old	Dummy variable: Older than 10 years	0.37
Household size: small	Dummy variable: 2 siblings or fewer	0.26
Household size: large	Dummy variable: more than 2 siblings	0.72
Read never	Dummy variable: Student never reads at home on his/her own	0.16
Read 1 to 3 times a week	Dummy variable: Student reads at home on his/her own 1 to 3 times a week	0.56
Read more than 3 times	Dummy variable: Student reads at home on his/her own more than 3 times a week	0.27
Books at home: Zero	Dummy variable: No books at student's home	0.19
Books at home: 1 to 10	Dummy variable: 1 to 10 books at student's home	0.48
Books at home > 10	Dummy variable: More than 10 books at student's home	0.32
Home language English	Dummy variable: Student's home language is English; reference category is any other language	0.04
Speak English 0	Dummy variable: Student never speaks English at home	0.56
Speak English 1-3 times	Dummy variable: Student speaks English at home 1 to 3 times a week	0.31
Speak English 4+	Dummy variable: Student speaks English at home more than 3 times a week	0.13
English on TV 0	Dummy variable: Student never hears English on TV	0.23
English on TV 1-3 times	Dummy variable: Student hears English on TV 1 to 3 times a week	0.33
English on TV 4+	Dummy variable: Student hears English on TV more than 3 times a week	0.44

[95] This is the mean amongst students rather than amongst schools.

Table A.13: School level variables (Principal questionnaires of 2007 and 2008)

Variable name	Description	Weighted mean[96]
Mean School SES	Mean of student SES within each school: Min = 0, std dev = 1	2.15
Pupil-teacher ratio	Number of enrolled students divided by the number of teachers at each school	31.27
Students per grade 4 classroom	Number of enrolled grade 4 students divided by the number of classrooms allotted to grade 4 in each school	46.25
Media and Communication facilities index	Z-scored index for the presence and functionality of the following: phone, fax, internet/email, copying facility, computer for administration, computer for staff, computers for students, TV/video and overhead projector	0.18
Full set of class texts present	Dummy variable: Principal maintained there was at least one full set of class texts present. Reference category: Full set not present	0.33
Teacher absenteeism zero	Dummy variable: No teachers absent on the day of the survey; Reference category: some teachers absent	0.29
LTSM Inventory good	Dummy variable: LTSM inventory complete and up to date	0.50
LTSM Inventory average	Dummy variable: LTSM inventory present but incomplete and not up to date	0.28
LTSM Inventory poor	Dummy variable: LTSM inventory not able to be seen	0.22
Problems with students index	Z-scored index combining several evaluations of the extent of problems with student discipline and work ethic in the school (mean = 0, std. dev = 1)	0.08
Curriculum planned using year schedule	Dummy variable: Principal reported that curriculum planning occurs using a year schedule. Reference category: Curriculum planning does not involve a year schedule.	0.53
No timetable available	Dummy variable: No school timetable could be shown to fieldworker. Reference category: Fieldworker saw a timetable.	0.06
Assessment record keeping very good	Dummy variable derived from a summative index combining a number of questions regarding the presence and completeness of assessment records	0.11
Assessment record keeping good	Dummy variable derived from a summative index combining a number of questions regarding the presence and completeness of assessment records	0.57
Assessment record keeping poor	Dummy variable derived from a summative index combining a number of questions regarding the presence and completeness of assessment records	0.20
Assessment record keeping very poor	Dummy variable derived from a summative index combining a number of questions regarding the presence and completeness of assessment records	0.07

[96] This is the mean amongst students rather than amongst schools.

Table A.14: Teacher level variables (Teacher questionnaire of 2008)

Variable name	Description	Weighted mean[97]
Full year learning programme	Dummy variable: Fieldworker was shown a learning programme for the full year	0.50
English teacher test score: 1 or 2[98]	Dummy variable: Teacher scored 1 or 2 on the comprehension test	0.10
English teacher test score: 3	Dummy variable: Teacher scored 3 on the comprehension test	0.13
English teacher test score: 4 or 5	Dummy variable: Teacher scored 4 or 5 on the comprehension test	0.29
English teacher test score: 6 or 7	Dummy variable: Teacher scored 6 or 7 on the comprehension test	0.25
Maths teacher test score: 1 out of 5	Dummy variable: Teacher scored 1 out of 5 on the maths test	0.19
Maths teacher test score: 2 out of 5	Dummy variable: Teacher scored 2 out of 5 on the maths test	0.24
Maths teacher test score: 3 out of 5	Dummy variable: Teacher scored 3 out of 5 on the maths test	0.18
Maths teacher test score: 4 out of 5	Dummy variable: Teacher scored 4 out of 5 on the maths test	0.10
Maths teacher test score: 100%	Dummy variable: Teacher scored 5 out of 5 on the maths test	0.10
Time spent teaching: less than 10 hours	Dummy variable: Maths teacher reported spending less than 10 hours per week on actual teaching	0.10
Time spent teaching: 10 to 18 hours	Dummy variable: Maths teacher reported spending between 10 and 18 hours per week on actual teaching	0.25
Time spent teaching: 19 to 26 hours	Dummy variable: Maths teacher reported spending between 19 and 26 hours per week on actual teaching	0.41
Time spent teaching: more than 26 hours	Dummy variable: Maths teacher reported spending more than 26 hours per week on actual teaching	0.16
Time spent on assessment: vlow	Dummy variable: English Teacher reported spending one hour or less per week on assessment	0.15
Time spent on assessment: low	Dummy variable: English Teacher reported spending between one and three hours per week on assessment	0.16
Time spent on assessment: high	Dummy variable: English Teacher reported spending between three and five hours per week on assessment	0.23
Time spent on assessment: vhigh	Dummy variable: English Teacher reported spending 5 hours or more per week on assessment	0.31
Time spent on assessment: vlow	Dummy variable: Maths Teacher reported spending one hour or less per week on assessment	0.10
Time spent on assessment: low	Dummy variable: Maths Teacher reported spending between one and three hours per week on assessment	0.15
Time spent on assessment: high	Dummy variable: Maths Teacher reported spending between three and five hours per week on assessment	0.24
Time spent on assessment: vhigh	Dummy variable: Maths Teacher reported spending 5 hours or more per week on assessment	0.37

[97] This is the mean amongst students rather than amongst schools.

[98] Scores of zero were relatively few and were associated with strong student performance, strangely. It is possible that many these were instances where teachers refused to take the test or for some reason other than extremely poor knowledge recorded a score of zero. Therefore, these cases were grouped together with cases of non-response.

Short word exercises: low frequency	Dummy variable: Fewer than 10 short word exercises found in student workbooks	0.21
Short word exercises: average frequency	Dummy variable: Between 10 and 25 short word exercises found in student workbooks	0.44
Short word exercises: high frequency	Dummy variable: More than 25 short word exercises found in student workbooks	0.15
Long sentence exercises: none	Dummy variable: No long sentence exercises found in student workbooks	0.32
Long sentence exercises: 1 to 4 times	Dummy variable: Between 1 and 4 long sentence exercises found in student workbooks	0.19
Long sentence exercises: more than 4 times	Dummy variable: More than 4 long sentence exercises found in student workbooks	0.08
Number of complex maths exercises: fewer than 18	Dummy variable: Fewer than 18 complex maths exercises found in student workbooks	0.76
Number of complex maths exercises: 18 plus	Dummy variable: More than 18 complex maths exercises found in student workbooks	0.12
Maths topics covered: < 10	Dummy variable: Fewer than 10 maths topics covered according to fieldworker review of student workbooks	0.23
Maths topics covered: 10 to 25	Dummy variable: Between 10 and 25 maths topics covered according to fieldworker review of student workbooks	0.44
Maths topics covered: 25 plus	Dummy variable: More than 25 maths topics covered according to fieldworker review of student workbooks	0.26

Note: In the above tables, where the means of a set of dummy variables does not add up to 1, this is due to non-response.

Appendix J: Multivariate models for NSES not shown in Chapter 4

Table A.15: OLS Regression models for literacy 2008

Explanatory variables	[A]Excluding 2007 score		[B]Including 2007 score	
Student characteristics				
Literacy score 2007			0.44***	(0.02)
Student SES	0.39*	(0.18)	0.23	(0.16)
Male	-2.48***	(0.26)	-1.67***	(0.24)
Young	-0.40	(0.46)	0.12	(0.37)
Old	-2.84***	(0.33)	-2.35***	(0.32)
Age unspecified	-7.84***	(1.46)	-5.79***	(1.53)
Household size: large	-1.89***	(0.37)	-1.13***	(0.30)
Household size: unspecified	-1.15	(1.13)	0.04	(0.81)
Read 1 to 3 times a week	1.37**	(0.44)	0.73~	(0.39)
Read more than 3 times	2.39***	(0.62)	1.82***	(0.53)
Reading unspecified	-5.31*	(2.07)	-2.16	(1.84)
Books at home: 1 to 10	0.60	(0.39)		
Books at home > 10	1.17*	(0.48)		
Home language English	8.42***	(1.52)	4.74***	(1.15)
Speak English 1-3 times	1.75***	(0.38)	1.70***	(0.33)
Speak English 4+	1.86**	(0.68)	1.54**	(0.51)
Speak English unspecified	-5.74***	(1.56)	-3.80*	(1.49)
English on TV 1-3 times	0.85*	(0.39)	0.70~	(0.37)
English on TV 4+	3.35***	(0.44)	2.67***	(0.43)
English on TV unspecified	-2.70~	(1.59)	0.70	(1.59)
Eastern Cape	0.52	(2.28)	-1.05	(1.65)
Northern Cape	-3.17	(2.43)	-2.69	(2.26)
Free State	-3.71*	(1.77)	-4.09**	(1.35)
KwaZulu-Natal	1.10	(2.24)	-0.36	(1.57)
North West Province	-1.44	(2.61)	-2.63	(1.69)
Mpumalanga	-3.43~	(2.03)	-3.26*	(1.51)
Limpopo	-4.69*	(2.05)	-3.51*	(1.46)
School characteristics				
Mean School SES	-9.13***	(1.77)	-4.91**	(1.66)
Mean School SES squared	3.35***	(0.45)	1.85***	(0.38)
Pupil-teacher ratio	-0.18**	(0.07)	-0.06	(0.05)
Teacher absenteeism zero	1.93*	(0.81)		
Teacher absenteeism unsp.	0.28	(2.02)		
LTSM Inventory good	1.66*	(0.80)	1.34*	(0.60)
Problems with students index	-0.96*	(0.43)	-0.83**	(0.32)
Curriculum planned using year schedule	1.46~	(0.81)	1.35*	(0.66)
No timetable available			-2.55~	(1.38)
Teacher characteristics				
Full year learning programme	1.55~	(0.87)	1.12~	(0.65)
Learning programme unsp.	1.60	(1.09)	2.21~	(1.13)

Table A.15 (continued)

Explanatory variables	[A]Excluding 2007 score		[B]Including 2007 score	
Short word exercises: average frequency			0.39	(0.83)
Short word exercises: high frequency			1.66~	(0.97)
Short word exercises: unspecified			0.06	(1.13)
Constant	29.69***	(3.45)	19.16***	(2.67)
R-squared statistic	0.4591		0.5607	
N	10860		10860	

Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

Table A.16: OLS Regression models for numeracy 2008

Explanatory variables	[1]Excluding 2007 score		[2]Including 2007 score	
Student characteristics				
Numeracy score 2007			0.48***	(0.02)
Student SES	0.26	(0.27)	-0.06	(0.21)
Male	-1.13**	(0.35)	-0.61*	(0.30)
Young	-0.07	(0.72)	0.22	(0.52)
Old	-3.99***	(0.53)	-2.88***	(0.47)
Age unspecified	-9.70***	(2.75)	-9.14***	(1.82)
Household size: large	-2.37***	(0.54)	-1.86***	(0.42)
Household size: unsp.	-0.87	(1.61)	1.21	(1.50)
Read 1 to 3 times a week	3.49***	(0.67)	1.72***	(0.51)
Read more than 3 times	4.97***	(1.07)	3.36**	(1.21)
Reading unspecified	-6.17*	(2.62)	-1.28	(2.90)
Home language English	9.87***	(2.01)	6.82***	(1.57)
Speak English 1-3 times	2.43***	(0.65)	1.81**	(0.59)
Speak English 4+	2.01~	(1.05)	1.72*	(0.86)
Speak English unspecified	-8.98***	(1.87)	-4.92**	(1.56)
English on TV 1-3 times	0.66	(0.66)	0.01	(0.56)
English on TV 4+	4.50***	(0.69)	2.63***	(0.54)
English on TV unspecified	-11.75***	(2.16)	-7.53***	(2.02)
Eastern Cape	2.70	(3.11)	-2.25	(2.03)
Northern Cape	-1.24	(3.65)	-4.05	(4.01)
Free State	-2.83	(2.66)	-7.27***	(1.73)
KwaZulu-Natal	5.90*	(2.96)	0.64	(2.13)
North West Province	-1.14	(3.31)	-7.39**	(2.23)
Mpumalanga	-2.32	(3.12)	-6.70***	(1.84)
Limpopo	-4.75	(2.97)	-7.21***	(1.61)
School characteristics				
Mean School SES	-16.89***	(3.38)	3.05***	(0.82)
Mean School SES squared	4.88***	(0.78)		
Pupil-teacher ratio	-0.38***	(0.11)	-0.28**	(0.09)
Media and Communication facilities index	2.45*	(1.02)		
Assessment record keeping good	0.25	(1.88)		
Assessment record keeping poor	-2.79	(2.16)		
Assessment record keeping very poor	-4.87*	(2.41)		
No timetable available	-4.87*	(2.43)	-4.52**	(1.62)
Teacher absenteeism zero	2.74*	(1.38)	2.24*	(1.13)
Teacher absenteeism unsp.	6.51**	(2.38)	0.98	(1.37)
Curriculum planned using year schedule			1.70	(1.07)
Teacher characteristics				
Maths teacher test score: 100%	2.99~	(1.77)	2.93~	(1.67)
Maths teacher test unsp.	-2.59	(2.07)	-2.91*	(1.45)
Maths topics covered: 25 plus	4.69**	(1.54)	2.28*	(1.14)
Maths topics covered: unsp.	6.99*	(3.36)	6.15**	(2.33)

Table A.16 (continued)

Explanatory variables	**[1]Excluding 2007 score**		**[2]Including 2007 score**	
Time spent on assessment: low			4.60**	(1.58)
Time spent on assessment: high			4.65**	(1.77)
Time spent on assessment: vhigh			2.44	(1.50)
Time spent on assessment: unsp.			2.13	(1.71)
Constant	50.05***	(5.08)	20.53***	(3.59)
R-squared statistic	0.4223		0.5646	
N	11383		11813	

Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

Table A.17: OLS Regression models for literacy in historically black schools

Explanatory variables	[1]Excluding 2007 score		[2]Including 2007 score	
Student characteristics				
Literacy score 2007			0.44***	(0.03)
Student SES	0.28	(0.17)	0.08	(0.15)
Male	-2.30***	(0.25)	-1.68***	(0.24)
Young	-0.49	(0.47)	0.04	(0.35)
Old	-2.73***	(0.33)	-2.36***	(0.29)
Age unspecified	-8.72***	(1.44)	-6.56***	(1.34)
Household size: large	-1.11**	(0.41)	-0.79*	(0.33)
Household size: unsp.	-1.15	(1.00)	-0.34	(0.72)
Read 1 to 3 times a week	1.21**	(0.46)	0.64	(0.43)
Read more than 3 times	1.96**	(0.64)	1.54**	(0.56)
Reading unspecified	-3.42*	(1.62)	-1.31	(1.50)
Books at home: 1 to 10			0.70*	(0.33)
Books at home > 10			0.47	(0.41)
Speak English 1-3 times	1.95***	(0.44)	1.69***	(0.35)
Speak English 4+	1.55~	(0.89)	1.40*	(0.63)
Speak English unsp.	-5.47***	(1.48)	-2.73~	(1.49)
English on TV 1-3 times	0.92*	(0.39)	0.68*	(0.34)
English on TV 4+	3.04***	(0.42)	2.17***	(0.35)
English on TV unsp.	-3.51*	(1.59)	-0.62	(1.52)
Eastern Cape	3.48~	(1.90)	2.58*	(1.30)
Northern Cape	4.03	(2.91)	4.10	(2.81)
Free State	-1.88	(1.90)	-0.68	(1.50)
KwaZulu-Natal	2.46	(1.86)	2.87*	(1.32)
Mpumalanga	-1.59	(1.97)	0.01	(1.48)
Limpopo	-2.02	(1.92)	0.66	(1.36)
School characteristics				
Mean School SES	-5.11*	(2.50)	-3.92*	(1.86)
Mean School SES squared	2.09**	(0.77)	1.55**	(0.54)
Pupil-teacher ratio	-0.01	(0.07)	-0.03	(0.05)
Students per grade 4 classroom	-0.04*	(0.02)		
Teacher absenteeism zero	2.10**	(0.79)	1.98**	(0.63)
Teacher absenteeism unsp.	3.54	(2.35)	0.86	(1.12)
No timetable available	-3.04*	(1.51)		
Teacher characteristics				
Full year learning programme			1.24*	(0.63)
Learning programme unsp.			1.96	(1.52)
Time spent on assessment: low	1.15	(1.11)	0.46	(0.93)
Time spent on assessment: high	3.59**	(1.32)	1.88*	(0.95)
Time spent on assessment: vhigh	0.08	(1.26)	-0.71	(0.96)
Time spent on assessment: unsp.	1.66	(1.11)	-1.60	(1.61)
Constant	27.77***	(3.80)	14.87***	(2.56)
R-squared statistic	0.1869		0.3146	
N	8868		9232	

Table Notes:

~ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
(Standard errors in parentheses)

Western Cape was excluded due to small sample size. The reference category for province is therefore the North West Province.

Table A.18: OLS Regression models for numeracy in historically black schools

Explanatory variables	[1]Excluding 2007 score		[2]Including 2007 score	
Student characteristics				
Numeracy score 2007			0.47***	(0.03)
Student SES	0.13	(0.28)	-0.01	(0.22)
Male	-1.07**	(0.37)	-0.77*	(0.33)
Young	-0.36	(0.80)	0.01	(0.55)
Old	-3.64***	(0.51)	-2.45***	(0.49)
Age unspecified	-10.04***	(2.98)	-9.09***	(1.81)
Household size: large	-1.05	(0.63)	-1.12*	(0.50)
Household size unsp.	-2.92	(1.61)	-1.49	(1.42)
Read 1 to 3 times a week	3.21***	(0.73)	1.60**	(0.61)
Read more than 3 times	4.32***	(1.25)	3.06*	(1.38)
Reading unspecified	-4.11	(2.68)	-0.18	(2.87)
Speak English 1-3 times	2.19**	(0.69)	1.84**	(0.63)
Speak English 4+	0.69	(1.35)	0.95	(1.16)
Speak English unsp.	-8.66***	(1.86)	-4.17*	(1.63)
English on TV 1-3 times	0.54	(0.68)	0.47	(0.58)
English on TV 4+	3.77***	(0.70)	2.65***	(0.54)
English on TV unsp.	-10.54***	(2.30)	-6.39**	(2.06)
Eastern Cape	4.85	(2.88)	4.07	(2.23)
Northern Cape	5.10	(4.39)	10.43*	(4.31)
Free State	-2.45	(2.97)	-0.16	(2.26)
KwaZulu-Natal	6.76*	(2.90)	7.51**	(2.39)
Mpumalanga	0.45	(3.22)	2.58	(2.37)
Limpopo	-2.92	(2.48)	0.55	(1.97)
School characteristics				
Mean School SES	-8.91~	(4.65)	1.44	(1.14)
Mean School SES squared	2.46~	(1.26)		
Pupil-teacher ratio	-0.16	(0.12)	-0.13	(0.11)
Media and Communication facilities index	2.17*	(0.98)		
Assessment record keeping good	0.34	(2.35)		
Assessment record keeping poor	-2.29	(2.45)		
Assessment record keeping very poor	-4.88*	(2.46)		
Teacher absenteeism zero	3.03~	(1.61)	3.10*	(1.32)
Teacher absenteeism unsp.	5.09	(2.81)	1.01	(1.52)

Table A.18 (continued)

Explanatory variables	**[1] Excluding 2007 score**		**[2] Including 2007 score**	
Teacher characteristics				
Maths topics covered: 25 plus	5.81***	(1.62)	2.69~	(1.37)
Maths topics covered: unsp.	4.45	(2.52)	3.68	(2.17)
Time spent on assessment: low			3.02~	(1.64)
Time spent on assessment: high			4.38*	(1.96)
Time spent on assessment: vhigh			0.38	(1.61)
Time spent on assessment: unsp.			1.00	(2.12)
Constant	35.10***	(6.22)	12.19**	(3.91)
R-squared statistic	0.1691		0.3685	
N	8838		9232	

Notes:

~ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
(Standard errors in parentheses)

Western Cape was excluded due to small sample size. The reference category for province is therefore the North West Province.

Table A.19: HLM model for Literacy in grade 4 (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	27.27***
School mean SES	4.51***
Pupil-teacher ratio	-0.43*
Media and Communication facilities index	1.54**
Full set of class texts present	2.35*
Curriculum planned using year schedule	2.17*
LTSM Inventory good	3.42***
No timetable available	-6.76**
English teacher test score: 1 or 2	-3.03
English teacher test score: 3	-3.98*
English teacher test score: 4 or 5	-0.85
Teacher test score unspecified	1.40
The student SES achievement slope, β_1	
Intercept	0.62***
School mean SES	0.73**
English teacher test score: 6 or 7	1.26**
Long sentence exercises: 1 to 4 times	0.13
Long sentence exercises: more than 4 times	1.96*
Long sentence exercises unspecified	0.61
Male	-2.25***
Young	0.50~
Old	-3.06***
Age unspecified	7.69***
Household size: large	-0.99***
Household size: unspecified	-0.60
Read 1 to 3 times a week	0.82~
Read more than 3 times	1.66**
Reading unspecified	-4.82*
Speak English 1-3 times	1.58***
Speak English 4+	1.39*
Speak unspecified	-6.42***
English on TV 1-3 times	0.65*
English on TV 4+	3.13***
English on TV unspecified	0.26

Random effects	**Variance Components**
Intercept, $\mu 0j$	50.12***
Student SES slope, $\mu 1j$	1.08
Level-1 error, rij (σ^2)	95.01

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table Notes:

Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Rho value (ICC) = 0.53
Proportion of within-school variance explained by the model = 0.08
Proportion of between-school variance in the average achievement (**β_0**) explained by the model = 0.57
Proportion of between-school variance in the SES slope (**β_1**) explained by the model = 0.52

Table A.20: HLM model for Literacy in grade 4 (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	27.00***
School mean SES	2.63***
Pupil-teacher ratio	-0.23*
Media and Communication facilities index	0.85~
Curriculum planned using year schedule	2.07**
LTSM Inventory good	2.56***
No timetable available	-4.91**
English teacher test score: 1 or 2	-1.40
English teacher test score: 3	-2.55*
English teacher test score: 4 or 5	-0.81
Teacher test score unspecified	0.62
Literacy score 2007 (grade 3)	0.41***
Student SES	0.27
Male	-1.57***
Young	0.61*
Old	-2.75***
Age unspecified	-7.31***
Household size: large	-0.86**
Household size: unspecified	0.54
Read 1 to 3 times a week	0.46
Read more than 3 times	1.19*
Reading unspecified	-2.59
Speak English 1-3 times	1.42***
Speak English 4+	1.39*
Speak unspecified	-5.25***
English on TV 1-3 times	0.34
English on TV 4+	2.32***
English on TV unspecified	2.74

Random effects	**Variance Components**
Intercept, $\mu 0j$	26.94***
Level-1 error, rij (σ^2)	83.95

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Rho value (ICC) = 0.53
Proportion of within-school variance explained by the model = 0.19
Proportion of between-school variance in average achievement (β_0) explained by the model = 0.77

Table A.21: HLM model for Numeracy in grade 4 (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	36.06***
School mean SES	1.21
Pupil-teacher ratio	-0.61***
Media and Communication facilities index	3.77***
Curriculum planned using year schedule	4.09**
LTSM Inventory average	-3.98*
LTSM Inventory poor	-4.49~
No timetable available	-8.50**
Maths teacher test score: 100%	5.74~
Teacher test score unspecified	-3.96
Time spent teaching: 10 to 18 hours	3.49
Time spent teaching: 19 to 26 hours	7.54**
Time spent teaching: more than 26 hours	7.91*
Time spent teaching: unspecified	11.47**
Maths topics covered: 10 to 25	0.80
Maths topics covered: 25 plus	6.48**
Maths topics covered: unspecified	10.40~
Number of complex maths exercises: 18 plus	5.90*
Complex maths exercises: unspecified	-2.74
Student SES	0.32
Male	-0.77*
Young	1.09*
Old	-4.03***
Age unspecified	-11.62
Household size: large	-1.46**
Household size: unspecified	-2.32~
Read 1 to 3 times a week	2.16***
Read more than 3 times	3.14***
Reading unspecified	-6.95**
Speak English 1-3 times	1.91***
Speak English 4+	0.87
Speak unspecified	-7.84***
English on TV 1-3 times	0.47
English on TV 4+	4.03***
English on TV unspecified	-5.30**

Random effects	**Variance Components**
Intercept, $\mu 0j$	120.91***
Level-1 error, rij (σ^2)	193.32

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Rho value (ICC) = 0.54
Proportion of within-school variance explained by the model = 0.06
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.50

Table A.22: HLM model for Numeracy in grade 4 (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	35.15***
School mean SES	1.75~
Pupil-teacher ratio	-0.36***
Media and Communication facilities index	1.49~
Curriculum planned using year schedule	2.75*
No timetable available	-8.68***
Maths teacher test score: 100%	4.06*
Teacher test score unspecified	-2.92
Time spent teaching: 10 to 18 hours	-0.13
Time spent teaching: 19 to 26 hours	3.47~
Time spent teaching: more than 26 hours	5.26*
Time spent teaching: unspecified	9.57**
Numeracy score 2007 (grade 3)	0.46***
Student SES	0.10
Male	-0.66*
Young	1.00**
Old	-3.21***
Age unspecified	-10.12***
Household size: large	-1.30**
Household size: unspecified	-0.93
Read 1 to 3 times a week	1.36**
Read more than 3 times	1.83**
Reading unspecified	-3.67~
Speak English 1-3 times	1.56***
Speak English 4+	0.80
Speak unspecified	-5.11***
English on TV 1-3 times	0.28
English on TV 4+	2.94***
English on TV unspecified	-1.97

Random effects	**Variance Components**
Intercept, μ0j	71.78***
Level-1 error, rij (σ^2)	155.22

~ $p<0.10$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table Notes:

Rho value (ICC) = 0.54
Proportion of within-school variance explained by the model = 0.25
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.70

Table A.23: HLM model for Literacy in grade 4 amongst historically black schools (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	23.38***
School mean SES	1.52
Pupil-teacher ratio	-0.10
Inventory average	-1.15
Inventory poor	-2.22*
Teacher absenteeism zero	2.90**
Teacher absenteeism unsp.	1.57
Student SES	0.28
Male	-2.19***
Young	0.17
Old	-2.79***
Age unspecified	-8.00***
Household size: large	-0.54~
Household size: unspecified	-0.72
Read 1 to 3 times a week	0.62
Read lots	1.30*
Reading unspecified	-2.86~
Speak English 1-3	1.62***
Speak English 4+	0.60
Speak English unspecified	-6.54***
English on TV 1-3	0.51
English on TV 4+	2.80***
English on TV unspecified	-0.03

Random effects	**Variance Components**
Intercept, $\mu 0j$	34.39***
Level-1 error, rij (σ^2)	84.39

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Rho value (ICC) = 0.32
Proportion of within-school variance explained by the model = 0.07
Proportion of between-school variance in β_0 explained by the model = 0.18

Table A.24: HLM model for Literacy in grade 4 amongst historically black schools (including grade 3 score)

Intercept, β_0 (Average achievement)	Coefficients
Intercept	23.33***
School mean SES	1.20
Pupil-teacher ratio	-0.07
Curriculum planned using year schedule	1.36~
LTSM Inventory average	-1.14
LTSM Inventory poor	-1.19
No timetable available	-2.11~
Teacher absenteeism zero	1.93*
Teacher absenteeism unsp.	-1.14
Literacy score 2007 (grade 3)	0.38***
Student SES	0.15
Male	-1.61***
Young	0.39
Old	-2.57***
Age unspecified	-7.11***
Household size: large	-0.55~
Household size: unspecified	0.47
Read 1 to 3 times a week	0.39
Read more than 3 times	1.04~
Reading unspecified	-1.29
Speak English 1-3 times	1.49***
Speak English 4+	0.82
Speak unspecified	-5.21
English on TV 1-3 times	0.37
English on TV 4+	2.11***
English on TV unspecified	1.94

Random effects	Variance Components
Intercept, $\mu 0j$	20.40***
Level-1 error, rij (σ^2)	75.75

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Only the student SES achievement slope was allowed to vary between schools and was group-mean centred.

Rho value (ICC) = 0.32
Proportion of within-school variance explained by the model = 0.17
Proportion of between-school variance in average achievement (**β_0**) explained by the model = 0.52

Table A.25: HLM model for Numeracy in grade 4 amongst historically black schools (excluding grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	30.67***
School mean SES	-2.33~
Pupil-teacher ratio	-0.15
Media and Communication facilities index	2.17*
Inventory average	-1.61
Inventory poor	-4.20*
Teacher absenteeism zero	4.34*
Teacher absenteeism unsp.	2.82
Maths topics covered: 10 to 25	0.55
Maths topics covered: 25 plus	8.17***
Maths topics unspecified	11.24*
Number of complex maths exercises: 18 plus	5.93~
Complex exercises unspecified	-4.43
Male	-0.78*
Young	0.69
Old	-3.64***
Age unspecified	-11.68***
Household size: large	-0.88~
Household size: unspecified	-2.41~
Read 1 to 3 times a week	1.90***
Read lots	2.60***
Reading unspecified	-6.14**
Speak English 1-3	1.84***
Speak English 4+	-0.25
Speaking unspecified	-8.09***
English on TV 1-3	0.46
English on TV 4+	3.78***
English on TV unspecified	-4.79**

Random effects	**Variance Components**
Intercept, μ0j	97.06***
Level-1 error, rij (σ^2)	177.90

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Rho value (ICC) = 0.39
Proportion of within-school variance explained by the model = 0.05
Proportion of between-school variance in β_0 explained by the model = 0.19

Table A.26: HLM model for Numeracy in grade 4 amongst historically black schools (including grade 3 score)

Intercept, β_0 (Average achievement)	**Coefficients**
Intercept	30.42***
School mean SES	0.11
Pupil-teacher ratio	-0.13
No timetable available	-4.72*
Teacher absenteeism zero	4.33*
Teacher absenteeism unsp.	3.02*
Maths teacher test score: 1 out of 5	-0.27
Maths teacher test score: 2 out of 5	-4.57
Maths teacher test score: 3 out of 5	-6.14*
Maths teacher test score: 4 out of 5	-4.56~
Teacher test unspecified	-7.21*
Time spent teaching: 19 to 26 hours	2.53~
Time spent teaching: more than 26 hours	2.75
Time spent teaching: unspecified	3.71
Maths topics covered: 10 to 25	0.40
Maths topics covered: 25 plus	3.56*
Maths topics unspecified	7.72*
Numeracy score 2007 (grade 3)	0.45***
Male	-0.75*
Young	0.81~
Old	-2.88***
Age unspecified	-10.01***
Household size: large	-0.95*
Household size: unspecified	-1.53
Read 1 to 3 times a week	1.12*
Read more than 3 times	1.39*
Reading unspecified	-3.07
Speak English 1-3 times	1.54**
Speak English 4+	0.01
Speaking unspecified	-4.99***
English on TV 1-3 times	0.25
English on TV 4+	2.77***
English on TV unspecified	-2.19

Random effects	**Variance Components**
Intercept, $\mu 0j$	60.56***
Level-1 error, rij (σ^2)	143.75

~ p<0.10 ; * p<0.05 ; ** p<0.01 ; *** p<0.001

Table Notes:

Rho value (ICC) = 0.39
Proportion of within-school variance explained by the model = 0.24
Proportion of between-school variance in β_0 explained by the model = 0.50

Appendix K: The calculation of appropriate weights for "TIMSS-matric" panel dataset

Those captured in matric were weighted up by the inverse of the proportion of the capturing rate relative to the GHS follow through rate, for each race.

Table A.27: Weighting calculations (For those captured)

	TIMSS capturing rate (T%)	GHS follow through rate (GHS%)	P=T%/GHS%	Weight=1/P
Black	25.34%	55.34%	0.457896	2.1839
Coloured	47.20%	53.56%	0.881309	1.134676
Indian	47.06%	88.08%	0.534304	1.871594
White	73.86%	86.65%	0.852405	1.173151

The overall weight provided by TIMSS is called "totwgt'. Therefore, for those captured the appropriate weighting system based on the above table was decided on as follows:

$$W_{Africans} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate}\right)^{-1} * totwgt = \left(\frac{25.34}{55.34}\right)^{-1} = \frac{1}{0.46} * totwgt = 2.18 * totwgt$$

$$W_{Coloureds} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate}\right)^{-1} * totwgt = \left(\frac{47.20}{53.56}\right)^{-1} * totwgt = \frac{1}{0.88} * totwgt = 1.13 * totwgt$$

$$W_{Indians} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate}\right)^{-1} * totwgt = \left(\frac{47.06}{88.08}\right)^{-1} * totwgt = \frac{1}{0.53} * totwgt = 1.87 * totwgt$$

$$W_{Whites} = \left(\frac{proportion\_captured}{GHS\_follow\_through\_rate}\right)^{-1} * totwgt = \left(\frac{73.86}{86.65}\right)^{-1} * totwgt = \frac{1}{0.85} * totwgt = 1.17 * totwgt$$

Similarly, those not captured were weighted down by the inverse of the proportion of the "not captured rate" relative to the GHS dropout rate, for each race. Again, this was multiplied by "totwgt".

Table A.28: Weighting calculations (For those not captured)

	TIMSS not captured (T%)	GHS dropout rate (GHS%)	P=T%/GHS%	Weight=1/P
Black	74.66%	44.66%	1.67174	0.59818
Coloured	52.80%	46.44%	1.13695	0.87955
Indian	52.94%	11.92%	4.44128	0.22516
White	26.14%	13.35%	1.95805	0.51071

Appendix L: The probability of passing matric conditional upon reaching matric

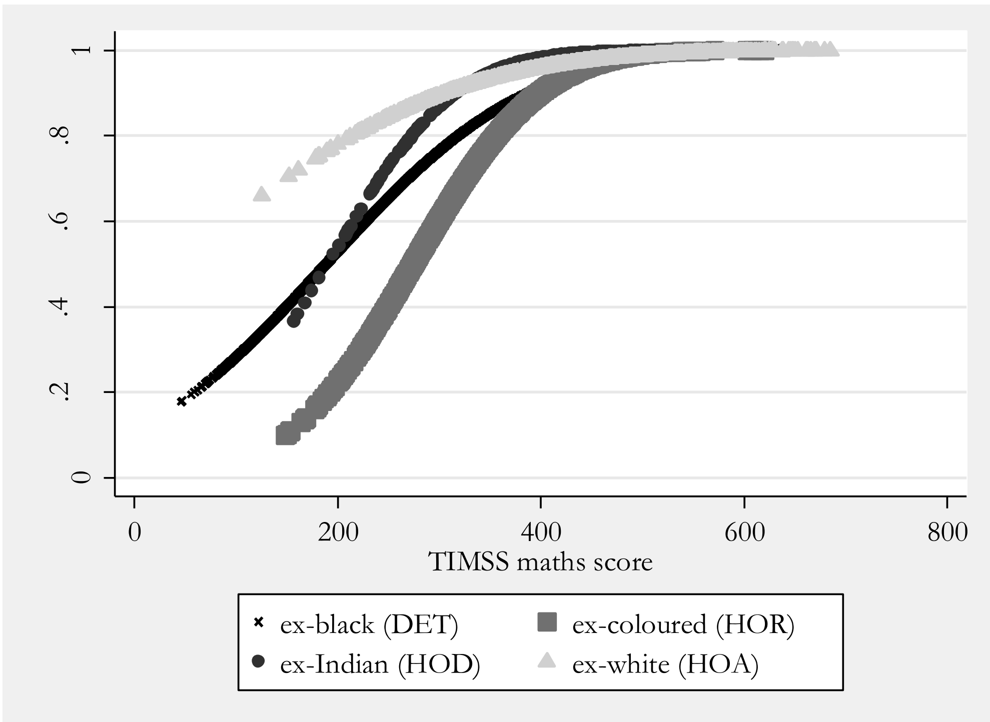
Table A.29: Probit regression predicting passing matric

(Dependent variable: Pass = 1; No pass = 0)

Explanatory variables	Marginal effects coefficient	Standard error
TIMSS maths score	0.00173**	0.00018
HOR (C)	-0.55535**	0.19702
HOD (I)	0. 23500	0.30161
HOA (W)	0.19768	0.09280
HOR*TIMSS maths	0.00100*	0.00047
HOD*TIMSS maths	-0.00010	0.00063
HOA*TIMSS maths	-0.00044	0.00047
Observations	2509	
Pseudo R-squared	0.1864	

*Significant at 5% level **Significant at 1% level

Figure A.3: Predicted probabilities of passing matric conditional upon reaching matric



Appendix M: Participation in matric mathematics by former department

Table A.30: Numbers participating in matric mathematics by former department

	DET (B)	HOR (C)	HOD (I)	HOA (W)	Total
Did not take maths	610	289	60	150	1109
Took maths	1157	198	96	304	1755
Total	1767	487	156	454	2864

Table A.31: Probit regression predicting taking maths in matric

(Dependent variable: took maths SG or HG = 1; Identified in matric but did not take maths = 0)

	DET (B)	HOR (C)	HOD (I)	HOA (W)
TIMSS maths score	0.00366**	0.00931**	0.01202**	0.00758**
	(0.00050)	(0.00100)	(0.00187)	(0.00078)
Constant	-0.51368**	-3.61391**	-4.12231**	-3.00166**
Pseudo R-squared	0.0248	0.1594	0.3007	0.1979
N	1767	487	156	454

*Significant at 5% level **Significant at 1% level

Note: Standard errors in parentheses