Teachers in the South African education system: An economic perspective

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DECLARATION

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ABSTRACT

Chapter 1 investigates teacher wages in the South African labour market, in order to ascertain whether teaching is a financially attractive profession, and whether high ability individuals are likely to be attracted to the teaching force. Making use of labour force survey data for the years 2000 to 2007 and for 2010, wage returns to educational attainment and experience are measured for teachers, non-teachers and non-teaching professionals. The returns to higher levels of education for teachers are significantly lower than for non-teachers and non-teaching professionals. Similarly, the age-wage profile for teachers is significantly flatter than it is for non-teachers, indicating that there is little wage incentive to remain in teaching beyond roughly 12 years. The profession is therefore unlikely to attract high ability individuals who are able to collect attractive remuneration elsewhere in the labour market.

Chapter 2 deals with explicit teacher incentives in education. It provides a technical analysis of Holstrom and Milgrom's (1991) multitasking model and Kandel and Lazear's (1992) model of peer pressure as an incentivising force, highlighting aspects of these models that are necessary to ensure that incentive systems operate successfully. The chapter provides an overview of incentive systems internationally, discussing elements of various systems that may be useful in a South African setting. The prospects for the introduction of incentives in South Africa are discussed, with the conclusion that the systems in place at the moment are not conducive to introducing teacher incentives. There are however models in Chile and Brazil, for example, that may work effectively in a South African setting, given their explicit handling of inequality within the education system. Chapter 3 makes use of hierarchical linear modelling to investigate which teacher characteristics impact significantly on student performance. Using data from the SACMEQ III study of 2007, an interesting and potentially important finding is that younger teachers are better able to improve the mean mathematics performance of their students. Furthermore, younger teachers themselves perform better on subject tests than do their older counterparts. Changes in teacher education in the late 1990s and early 2000s may explain the differences in the performance of younger teachers relative to their older counterparts. However, further investigation is required to fully understand these differences.

OPSOMMING

In Hoofstuk 1 word die lone van onderwysers in die Suid-Afrikaanse arbeidsmark ondersoek om vas te stel of onderwys ŉ finansieel aantreklike beroep is en hoe waarskynlik dit is dat mense met sterk vermoëns na die onderwys gelok sal word. Met gebruik van arbeidsmagopnamedata van 2000 tot 2007 en van 2010 word die loonopbrengs op jare onderwys en ervaring vir onderwysers, nie-onderwysers en beroepslui buite die onderwys gemeet. Die opbrengste vir hoër vlakke van opvoeding is beduidend laer vir onderwysers as vir nie-onderwysers en nie-onderwys beroepslui. Netso is die ouderdom-loonprofiel van onderwysers beduidend platter as vir nie-onderwysers, wat dui op weinig looninsentief om langer as ongeveer 12 jaar in die onderwysveld te bly. Dit is dus onwaarskynlik dat hierdie beroep baie bekwame mense sal lok wat elders in die arbeidsmark goed sou kon verdien.

In Hoofstuk 2 word na eksplisiete insentiewe in die onderwys gekyk. Die hoofstuk verskaf ŉ tegniese analise van die multi-taak-model van Holstrom en Milgrom (1991) en van Kandel en Lazear (1992) se model van portuur-druk as aansporingskrag, met klem op die aspekte van hierdie modelle wat in Suid-Afrikaanse omstandighede van nut mag wees. Vooruitsigte vir die instelling van insentiewe in Suid-Afrika word bespreek, met die slotsom dat die stelsels wat tans in plek is nie bevorderlik vir die instelling van onderwysersinsentiewe is nie. Daar is egter modelle in byvoorbeeld Chili en Brasilië wat effektief in Suid-Afrikaanse omstandighede sou kon funksioneer, gegewe hulle eksplisiete klem op ongelykheid binne die onderwys.

In Hoofstuk 3 word hiërargiese liniêre programmering gebruik om te ondersoek watter eienskappe van onderwysers ŉ belangrike invloed op studenteprestasie uitoefen. Met gebruik van data van die SACMEQ III studie van 2007 is ŉ interessante bevinding dat jonger onderwysers beter in staat is om die gemiddelde wiskunde prestasie van hulle student te verbeter. Verder vertoon sulke jonger onderwysers self ook beter in die vaktoetse in Wiskunde en taal as hulle ouer kollegas. Veranderings in onderwysopleiding in die laat negentigerjare en vroeë jare van hierdie eeu kan dalk die verskille in die vertonings van jonger onderwysers relatief tot hulle ouer eweknieë verklaar. Verdere ondersoek is egter nodig om hierdie verskille beter te verstaan.

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Introduction

The role of education and of teachers in South African economic development

Education and economic development are inextricably linked. Amartrya Sen (1997) explains development as the ability to choose the way in which one lives one's life and as having the capability to function at a certain level (Sen, 1997: 199). The process of development is therefore the process of enhancing the level of freedom that people have to live the life of their choice (Sen, 1999: 297). Different capabilities are interdependent according to this framework. For example, the level of educational attainment and the health status of people depend to a large extent on their level of income, yet the income individuals generate is governed to a large extent by their level of education and the state of their health (Sen, 1999: 19). In this way, freedom is both the means by which development is achieved as well as the ultimate objective.

A more conventional notion of economic development incorporates an element of economic growth, which includes the increase in per capita income over time (Ray, 1998: 7). On its own this is an incomplete notion of economic development. Economic development involves understanding how economic growth facilitates characteristics of development – health, life expectancy, sanitation and literacy – and how growth in per capita income results in long-term social change (Meier, 1995: 7). The traditional notion of economic development therefore needs to be broadened to encompass Sen's idea of development as freedom.

The role of education in economic development is vital. To some extent, access to education is seen as one of the outcomes of economic development. Access to basic education has been achieved in most countries in the world and the challenge facing governments internationally is enhancing the quality of education received by their citizens. Education is also a necessary driver of economic development, however. Indeed, the economic growth literature documents the role of "human capital" in economic growth, explaining that human capital is comprised of skills and knowledge, and that the generation and accumulation of human capital requires direct investment (Schultz, 1961: 1). Innovation and productivity are enhanced with higher levels of human capital. This applies at an individual level, too. The human capital model hypothesises that investment in education (and consequently higher levels of educational attainment) enhances individual productivity and in turn labour market earnings.

Education and South African economic development

Given its centrality in achieving a dignified standard of living as well as economic growth, education is one of the biggest components of government spending. In 2012, education comprised 20.6 percent of government expenditure in South Africa (World Bank, 2014). Furthermore, by far the largest expenditure item in education is teacher salaries. Personnel spending (comprised predominantly of teacher salaries) accounted for roughly 78 percent of education spending in South Africa in 2010 (Oxford Policy Management & University of Stellenbosch, 2012). From an economic perspective then, education is relevant and important, and the role of teachers is central to education.

South Africa's educational performance is worrying. Spaull (2013a: 53) provides a brief overview of South Africa's performance in an international perspective with a discussion of the results of three international studies conducted at different grades in the education system across different years. In 2006 South Africa was one of 45 countries participating in the Progress in Reading Literacy Study (at grade 4 and 5 level). Some other middle-income countries also participated in the study, namely Macedonia, Trinidad and Tobago, Indonesia and Morocco. More than three-quarters of the South African sample performed below the low international benchmark. This means that 78% of the South African sample may well never learn how to read, given their failure to achieve this basic level of competence at the grade 5 level (Trong, 2010: 2). In 2011, an easier version of the assessment, prePIRLS, was offered. PrePIRLS was designed specifically for underachieving developing countries and South Africa, Botswana and Colombia opted to participate in prePIRLS rather than PIRLS in 2011 (Spaull, 2013a: 53). The performance in prePIRLS was comparable to that of South Africa's neighbouring country Botswana. However, the average South African child was roughly three years behind the average Colombian child in grade 4.

South Africa also participated in international testing conducted by the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) in 2007. This was the third round of such testing and is referred to as SACMEQ III.[1] South Africa performed below the average of a number of African countries, even with lower pupil-teacher ratios, better qualified teachers and more resources (Van der Berg, Burger, Burger, De Vos, Du Randt, Gustafsson, Moses, Shepherd et al., 2011: 4).

[1] The data used in this analysis is from SACMEQ III. A thorough description of the study is presented in section 2 of this paper.

South Africa participated in the Trends in International Maths and Science Survey in 1995, 1995, 2002 and 2011 (Spaull, 2013a: 54). Despite marked improvement in performance between 2002 and 2011,[2] an international comparison of results reveals that South African grade 9 students were performing 2 to 3 grade levels below grade 8 students in countries at similar levels of income (Spaull, 2013b: 4). The improvement observed must therefore be considered in the context of excessively low performance in previous studies. In 2011, 76% of South African grade 9 students did not understand whole numbers, basic graphs, decimals or operations.

It is clear then that South Africa's education performance is less than desirable. Education performance differs dramatically across the socioeconomic spectrum, with a bimodal distribution characterising South African performance. Shepherd (2013: 3) explains that substantial and significant differences exist between historically black schools and schools serving other parts of the population. Van der Berg (2006: 6) reports that differences in the performance of rich and poor schools in South Africa far exceeded that of any other country in the SACMEQ II study (conducted in 2000).

South African's legacy of inequality in education therefore continues, with historical divisions still playing a major role, despite massive resource shifts towards schools with lower socioeconomic status. One area in which the equalisation of resources remains a challenge, however, is that of attracting skilled teachers to poor and often remote schools. The mid-1990s saw the Department of Education employing policies aimed at enhancing quality across the education system, an element of which included the equalisation of teacher provisions across schools (Crouch & Perry, 2003: 477). More teachers were employed in understaffed schools, and a policy of rationalisation and redeployment was conducted. Excess teachers were identified and were offered either posts at understaffed schools or voluntary severance packages. It became clear by 1998 that the areas in which there had been an undersupply of teachers had indeed experienced increased teacher numbers, but there was not an adequate reduction of teachers in areas where there was an oversupply. In order to remedy this situation, the DoE expedited the rationalisation process by decreasing enrolment in education training facilities and reducing the number of these facilities by roughly half. Teacher training colleges were later incorporated into universities and universities of technology (discussed in chapter 3)

[2] An improvement of approximately one and half grades was observed for the South African sample between 2002 and 2011 (Reddy et al., 2012). However, in 2011 only grade 9s in South Africa (compared to a mixture of grade 8s and grade 9s in 2002) wrote the grade 8 level test.

(Crouch & Perry, 2003: 479). The supply of teachers was affected significantly by these measures.

How best to remedy the state of education in South Africa? What can be done to improve the educational quality? The difficulties and nuances in education are numerous and it may be argued that a focus on any particular aspect of education is too narrow to realistically impact on the status quo. Even if one specific resource is isolated – in this case teachers – multiple factors determine effectiveness and quality. Furthermore, most of these factors are outside the scope of economics.

Teachers and their role in improving educational outcomes

This thesis investigates teachers in the South African education system, seeking inter alia to understand the attractiveness of teaching from a labour market perspective by comparing the wage structure facing teachers with that facing non-teachers, including non-teaching professionals. It then investigates the theoretical underpinning of incentives in teaching and the prospects for success of such incentives in South Africa. Finally, an analysis of the relationship between teacher characteristics and student performance is conducted.

Teachers are one of many inputs in the education process, so why focus on this particular resource in isolation from the myriad of factors impacting on student performance? Vegas and Umanksy (2005: 14) explain that at lower levels of material resources, the teacher becomes increasingly important in ensuring that learning takes place, and Hanushek contends that "by many accounts, the quality of teachers is the key element to improving student performance" (Hanushek, 2009: 171). The state of South African education renders it crucial to understand the mechanics determining who enters the teaching profession, what is done to encourage and manage teacher effort and how effective teachers are identified.

Economics provides tools which are particularly pertinent to the analysis of teachers' role in education. Economists are, for instance, well placed to analyse the structure of teacher remuneration and to compare it to that facing other professions. Economic models of the theoretical aspects of incentives faced by teachers are also useful for understanding the benefits and potential challenges associated with explicitly incentivising student performance. Finally, the education production function framework widely used in the economics of education literature provides a useful tool with which to consider the teacher characteristics most strongly associated with effective student performance. These are the topics that this thesis will deal with.

To what extent do we ensure that those entering the teaching force provide high quality teaching? There is considerable debate about the question whether it is possible to improve the performance of teachers already in the profession or whether the only genuine hope of ensuring high quality teaching is to ensure that high quality candidates enter the profession. Although by no means the only motivating factor for individuals entering teaching, the primary incentive for doing so is whether or not the profession is well paid (Hernani-Limarino, 2005: 65). We can think of the wage structure facing teachers as the financial consideration in terms of the labour market decision to join the teaching profession.

A profession that inherently attracts low quality teachers is catastrophic for education performance. To what extent does this characterise teaching in South Africa? To answer this question, this research investigates the attractiveness of the teaching profession from a wage perspective.

The question of whether teaching is an attractive profession from such a wage perspective depends on how the wages of teachers compare with those of non-teachers in the labour market. Gustafsson & Patel (2009: 11) show that despite sizeable increases in average teacher pay in the 1990s (which arose as a result of the equalisation of apartheid pay scales, an ageing teaching force and 'management drift' whereby teachers move into management positions paying higher salaries), the ratio of teacher pay to GDP has been declining since the late 1990s. This seems to contradict what the relative wage data is saying and may mean that the remuneration received by teachers is becoming increasingly less attractive relative to the rest of the economy. A comparison of the unconditional wage gap between teachers and non-teacher professionals in South Africa, that of developed countries the US and UK (Gould, Abraham & Bailey, 2005) and that observed in middle income countries in Latin America (Hernani-Limarino, 2005; Mizala & Romaguera, 2005) reveal that while the wage gap in South Africa is roughly in line with what is observed in developed countries, the wage gap is substantially larger in South Africa than it is in other middle income countries in Latin America, suggesting that the position of teachers in the South African labour market is somewhat less attractive than it is for their colleagues in Latin American countries (Gustafsson & Patel, 2009: 15). Therefore it appears that despite pay increases experienced during the 1990s, teacher wages have remained below those of non-teaching professionals.

Chapter 1 updates and continues the analysis of teacher wages in South Arica. The most recent wage data available, the Labour Force Surveys from 2000 to 2007 and the Quarterly Labour

Force surveys from 2010, are used to compare the wage structure of teachers with that of non-teachers and non-teaching professionals in the South African labour market. By making use of Mincerian wage functions as well as Lemieux decompositions, the returns to productive characteristics of teachers (education attainment and experience) are compared to those of non-teachers and non-teaching professionals. In order to investigate what impact this has on the quality of individuals entering the teaching profession, the distribution of grade 12 marks for students enrolled at different faculties at the University of Stellenbosch are investigated.

Whether teachers are well-paid is important to the extent that it ensures high quality teaching and therefore improved student performance. Although this research does not extend beyond an analysis of teacher pay, a further step in evaluating whether teachers are well-paid is therefore to consider how their pay affects student performance. The data requirements for this type of evaluation are extensive, but this is the question that should ultimately be answered. Does attractive remuneration persuade individuals best able to improve student performance to join the teaching profession, and does this ultimately improve education outcomes? Evidence from two studies – that of Menezes-Filho and Pazello (2007) using Brazilian data and a study using OECD data conducted by Dolton and Marcenaro-Gutierrez (2011) – suggests that improvements in teacher wages (Menezes-Filho & Pazello, 2007) or an attractive position in the wage distribution for teachers relative to other professionals (Dolton & Marcenaro-Gutierrez, 2011) is positively correlated with student performance. This may leave us optimistic about the prospect of improving education by attracting top-performers to the teaching profession. The details of these studies are discussed in chapter 1. In the case of South Africa, the data requirements to conduct such a study exceed data availability.

Wages may be thought of as the implicit incentives associated with the teaching profession. It is also important to understand whether there is scope for the introduction of explicit, pay-for-performance type incentives in teaching. Teacher incentives have been implemented internationally with the objective of ultimately improving student performance. Numerous examples of pay-for-performance type incentive systems exist which differ in their design, effectiveness and the duration of their effects. The results of such systems have been mixed. Chapter 2 focuses on explicit incentives in teaching. It provides a theoretical analysis of Milgrom and Holstrom's (1991) multitasking and risk of distortion model as well as Kandel and Lazear's (1992) model of peer pressure as an incentivising force. The chapter highlights key characteristics likely to render incentives successful in encouraging productive behaviour, provides evidence of where these systems have been successfully and unsuccessfully implemented internationally and discusses the likelihood of successful implementation of teacher incentive programmes in South Africa. This literature on the use of teacher incentives seems to suggest that they tend to improve student performance. However, very little evidence of the long term effects of *particular* incentive schemes exist. Furthermore, in an education system fraught with the level of inequality experienced in South Africa, it is vitally important to ensure that incentive systems do not exacerbate the problem by rewarding those teachers teaching in wealthier schools in which student performance is stronger. The result of such a trend may be that teachers better able to achieve higher levels of student performance are drawn to schools with these conditions, resulting in a distribution of teacher quality that favours schools already better placed to achieve high levels of educational outcomes.

Chapter 2 then considers the international literature on teacher incentives in education with a view to understanding whether or not the South African education system is likely to succeed in implementing incentive schemes for teachers, and whether or not these schemes are likely to result in improved student performance.

The first two chapters therefore examine the inherent attractiveness of the teaching profession as determined by its wage structure and the prospects for explicit incentives in South Africa's teaching profession. A final step is to consider what characteristics identify high quality teachers, in terms of their ability to have an effect on student learning. The challenge is to understand what best serves the objective of improving educational outcomes in South Africa. Having considered the attractiveness of the teaching profession in South Africa, it is also important to understand what type of individuals are likely to have the biggest impact on student performance.

Investigation into the relationship between teacher characteristics and student performance has yielded mixed results. Numerous studies across a wide range of countries have investigated the impact of various teacher-level variables on student performance. Studies have investigated the relationship between student performance and teacher demographic characteristics (Slater, Davies and Burgess, 2009), different types of teacher content knowledge (Hill, Loewenberg Ball & Schilling, 2008), teacher training and experience (Chingos & Peterson, 2011; Angrist & Lavy, 2001), teaching methods (Anderson, 2000), teacher test performance (Ehrenberg & Brewer, 1995; Hanushek, 1992; Rowan, Chiang & Miller, 1997), amongst others.

In the context of South Africa, Crouch & Mabogoane (1998) find a relationship between secondary school student performance and the number of years of post-secondary training amongst teachers. Using student performance data at a grade 6 level, Gustafsson (2007) explains that the effect of teacher training on student performance largely reflects the effect of apartheid's racially delineated teacher training institutions. For example, just 12% of white teachers report having received fewer than 4 years of training in comparison to some 44% of black teachers. Information on teacher training is largely understood to be a proxy for individual teacher's ability, so in cases where this data is available, the link between teacher test score and student performance is significantly stronger (Gustafsson & Patel, 2009: 6). This link is measured by Lee, Zuze & Ross (2005) using data from the SACMEQ II study for those countries that also participated in the testing of teachers, and the results show a strong relationship between teacher test scores and student performance. As is explained later, South African teachers were only tested in the third SACMEQ study and was thus not included in the SACMEQ II study. This thesis makes use of SACMEQ III data. Of importance in terms of the policy process is not whether or not teacher ability impacts on student performance, but rather whether there are any patterns in, for example, the link between teacher ability and teacher training (Gustaffson & Patel, 2009: 6). Gustafsson (2007: 12) finds a significant link between teacher behaviour variables (specifically, teacher punctuality) and student performance, as well as for different teaching methodologies. Importantly, the impact of teaching methodology appears to act independently of teacher training.

Chapter 3 adds to this literature by using hierarchical linear modelling to investigate which teacher characteristics (demographic and education background) contribute significantly to student performance. The relationship between teacher characteristics and student performance has been difficult to measure. However, significant relationships between both education and demographic characteristics have been found in developed and developing countries. As mentioned above, SACMEQ III is the first dataset in which teacher test results have been recorded in South Africa, allowing for different types of investigation around teacher test performance and teacher content knowledge than was possible in earlier studies. An interesting and important result found in chapter 3 is that there are important differences in the extent to which teachers of different ages are able to affect student performance, as well as differences in their performance on teacher tests. This relationship is not observed in other Sub-Saharan African countries participating in the SACMEQ III study (2007), nor is it observed in South African data from the earlier SACMEQ II (2000) study. Chapter 3 considers the possible explanations of this result, and also what this may mean in terms of teacher training and quality.

This thesis therefore provides an economic perspective on teachers in the South African education system. The wage structure and incentives faced by teachers may well influence first of all who enters the teaching profession and secondly who remains in teaching and the level of effort at which teachers are willing to perform. An investigation into the relationship between teacher characteristics and student performance may aid in identifying individuals most likely to enhance education outcomes amongst students. An understanding of teachers from an economic perspective may well provide a point of entry to investigating the processes that ultimately result in improved education outcomes.

Chapter 1

Teacher wages in South Africa: how attractive is the teaching profession?

"Attracting qualified individuals into the teaching profession, retaining those qualified teachers, providing them with the necessary skills and knowledge, and motivating them to work hard and to do the best job they can is arguably *the* key education challenge" (Vegas & Umansky, 2005).

The above statement was written in the context of Latin American schools and opens the first chapter of their book *Improving Teaching and Learning through Effective Incentives*. It is clear that the question of effective teachers and their role in educational performance is considered pertinent internationally, and this matter becomes increasingly important as the level of resources in communities decrease. A substantial amount of literature exists on policies designed to improve teacher quality. Such policies are broadly grouped into three categories: i) policies that aim to improve the preparation and professional development of teachers; ii) policies designed to affect who enters the teaching profession and the time these individuals remain in the teaching profession; and iii) policies designed to affect the work that teachers carry out in the classroom (Vegas & Umansky, 2005). Although this chapter looks at some of the literature on policies aimed at improving teacher quality, its focus is on the second category, and comprises a labour market overview of the wage structures in the teaching profession and how this compares to those in non-teaching professions where similar levels of education and labour market experience are required. The question this chapter seeks to answer is: "How attractive is the teaching profession from a labour market perspective?"

1. The importance of teachers in achieving quality education: A case for effective wage incentives

It is widely believed by both teachers and non-teachers in South Africa that teachers are under-paid. Indeed, it is widely thought that well-performing teachers are under-paid, and so at the upper end of the teacher skills distribution, this sentiment may well be founded. However, when mean student performance and mean teacher pay in South Africa is taken into account, it can be argued that teachers may in fact be over-paid, given the apparent lack of productivity associated with their work. One of the fundamental problems underlying this apparent lack of productivity is the fact that South Africa's teacher pay system barely differentiates between well and poorly performing teachers. This largely results from the fact that data on teacher quality are rare, if they exist at all (Taylor, Van der Berg, Spaull, Gustafsson & Armstrong, 2011: 4)

Internationally teachers are generally found to be under-paid relative to those employed in non-teaching professions, given their level of educational attainment and experience in the teaching force. It is often argued that this is the case because of the poor productivity of the profession relative to other professions. In the South African context, one is hard-pressed to argue that teachers should be paid more. Between 2007 and 2009, teachers experienced a 15 percent increase in real terms in average pay, despite the financial crisis. In fact, even before this substantial increase, teacher pay in South Africa was exceptionally high relative to per capita GDP. The question therefore becomes: How should teacher pay be adjusted in order to attain higher performance within South African schools? What is required is a pay system designed to incentivise good teaching as well as linking salary increments to experience in a way that discourages good teachers from leaving the profession. Indeed, top-performing teachers are often attracted out of the teaching profession and into private sector jobs with far more attractive wages (Taylor et al., 2011:6).

The importance of teachers in the South African education system should not be underestimated. In terms of the distribution of public resources, the proportion spent on teachers is immense. Gustafsson and Patel (2009:3) point out that approximately 3.0 percent of economically active South Africans are teachers (although this is limited to teachers who are publicly employed; this proportion increases to 4.5 percent if all individuals classifying themselves as teachers are counted), and the teacher wage bill is roughly 3.5 percent of GDP. In 2009 some 17.9 percent of government spending was spent on education, and 81.5 percent of that education spending was spent on teacher salaries (Gustafsson & Patel, 2009: 5) – a clear indication that an immense proportion of public spending on education is personnel spending. It is therefore important to investigate and understand the performance of teachers as their wages constitute a considerable expenditure item in the government's budget.

Low teacher effort and low levels of teacher skills present a sizeable challenge in the South African education system. Many argue that low teacher effort is a greater challenge to educational performance than a low level of teacher skills, suggesting that policy response in terms of teachers should be focused more on designing attractive incentives rather than on in-service training "solutions". Indeed, high levels of absence from classrooms, poor lesson preparation and very low levels of interest in the progress of learners are key signs that teacher effort is critically low in South Africa. It is often reported that such low levels of effort result from weak incentive systems. Furthermore, the structure of the teacher workforce, in particular the exceptionally strong influence that teacher unions have in the structuring of this workforce, make it close to impossible to even discuss changes to the status quo (Taylor et al., 2011:5).

In terms of teacher incentives, three key areas of empirical enquiry present themselves, namely the time that teachers actually spend teaching, whether or not teacher pay is considered adequate (as well as the structure of teacher salary scales), and the number of new teachers that are taken in annually (Taylor et al., 2011:6). All three are important in understanding the appeal of the teaching profession and the level of effort teachers are likely to provide. However, this chapter focuses solely on the adequacy of teacher pay. It takes a look at the earnings of teachers in comparison to those of their non-teaching counterparts in the South African labour force, investigating whether the profession is considered attractive from a labour market perspective.

This chapter addresses the question of the adequacy of teacher pay and the attractiveness of the profession as follows: Section 2 discusses some interesting international evidence from two studies that link teacher pay to student performance, suggesting perhaps that improving the financial attractiveness of the teaching profession may improve educational performance. Section 3 presents an analysis of teacher wages in which the remuneration structures of teachers and non-teachers are compared. Section 4 provides a brief analysis of the academic performance of students enrolled for education degrees in comparison to those enrolled in other areas of study as a possible explanation for the differences observed in the remuneration of the two groups. Section 5 concludes the paper with a summary of the results.

2. International evidence: Teacher pay and student performance

"In the 2003 PISA assessment ... Brazilian students had the lowest average outcome out of 40 countries, with a mean score of 350 in mathematics, relative to the OECD mean of 496. Moreover, Brazil is one of the most unequal countries in the world and education is often seen as the main culprit" (Menezes-Filho & Pazello, 2007: 660). This statement may well be applicable to the South African context - an enormously unequal country with a faltering education system which perpetuates the level of inequality and poverty experienced by a significant proportion of the population[3]. In 1998, Brazil introduced FUNDEF (*Fundo para Manutenção e Desenvolvimento do Ensino Fundamental e Valorização do Magistério*), an initiative designed to redistribute resources from richer regions to the poorer regions and to improve the wages of teachers in the Brazilian public sector (Menezes-Filho & Pazello, 2007: 660). A substantial amount of research exists around the issue of teacher pay and whether teachers are paid enough. Numerous studies of teacher pay have been conducted (Mizala & Romaguera, 2004; Ballou & Podgursky, 1997; Barnett, 2003; Hanushek, 2007). However, an important question seldom asked[4] is whether increased teacher wages impacted positively on student performance.

Menezes-Filho & Pazello (2007: 671) are able to show that increasing the wage of public school teachers in Brazil did impact positively on student performance. Taking advantage of the wage increase received by teachers in 1998, the authors instrument teacher wages with the municipality in which a school is located, year and schooling system (municipal or state) as well as their interactions. The positive impact of teacher wages on student performance seems largest for Portuguese, followed in turn by mathematics and science. The mechanism by which this works is unclear and the authors do not explore the possible channels of influence. It is an important relationship to understand, however, and one worth exploring in a country like South Africa, given its similarity to Brazil. Important to note is that the Brazilian study says nothing about whether new teachers were attracted to the profession as a result of higher wages. This is something to consider when investigating the impact of wages on student performance, i.e. the source of improvement. It is vital to understand whether it is possible to improve the

[3] An important differences between South Africa and Brazil is that Brazilian teacher wages are determined sub-nationally while the wages of South African teachers are determined at the national level.
[4] Hanushek, Rivkin and Kain (2005: 422) point out the difficulty in acquiring non-biased estimates of the impact of teacher wages on student performance given the influence of unobservable characteristics of students, teacher and schools.

proficiency of teachers already in the system or whether it is necessary to employ more able teachers to enhance teacher quality. The policy implications of these alternatives are quite different.

Dolton and Marcenaro-Gutierrez (2011) use cross-country data to test the relationship between teacher pay and student proficiency. Comparing teacher pay within countries is problematic. Cross-sectional variation in teacher remuneration is unlikely to render a measurable impact on student performance because each district has its own teacher supply curve (Dolton & Marcenaro-Gutierrez, 2011: 16). Furthermore, within a country teachers are likely to be paid according to the same or similar pay scales and are likely to be drawn from similar parts of the ability distribution. The result is that not enough variation in teacher wages and teacher quality exists to identify the relationship between teacher remuneration and student performance (Dolton & Marcenaro-Gutierrez, 2011: 16). The authors explain that only by using the variation in teachers' relative position in wage distribution across countries can researchers say something about teacher pay.

Dolton and Marcenaro-Gutierrez hypothesize that the relationship between teacher pay and educational outcomes (measured by student outcomes on standardised tests) works by attracting highly able people to the teaching profession by higher wages and by improving the standing of teachers in the national income distribution by attaching a certain status or prestige to the profession (Dolton & Marcenaro-Gutierrez, 2011: 8-9). As more individuals are attracted towards the profession by remuneration prospects, entry into teaching will become increasingly competitive and individuals of higher ability will want to enter teaching (Dolton & Marcenaro-Gutierrez, 2011: 8). The higher status of teaching will also render it a sought after profession, attracting a higher number of applicants and allowing training institutions to be more selective regarding who is admitted for teacher training, which in turn results in attracting individuals of higher ability to the profession. This process "facilitates the recruitment of more able individuals" to teaching (Dolton & Marcenaro-Gutierrez, 2011:9).

Dolton and Marcenaro-Gutierrez use data on teachers and education systems from the OECD's *Education at a Glance* publications. Data from 39 countries between 1996 and 2009 for 39 countries are used, as well as student performance data from the Programme for International Student Assessment (PISA) surveys and the Trends in International Mathematics and Science

Study (TIMSS)[5]. The authors investigate whether improving teachers' relative standing in the income distribution within their country improves student performance (Dolton & Marcenaro-Gutierrez, 2011: 21)[6]. A strong, positive and statistically significant relationship exists between teacher wages and student test performance (Dolton & Marcenaro-Gutierrez, 2011: 41). They find that a 10% increase in teacher wages translate into improvements in student performance of 5% to 10%, and that a 5% improvement in relative position of the earnings distribution has a similar effect on student performance.

Mehrotra & Buckland (2001: 4570) report that in most countries, teacher salary scales take account of teacher qualifications in the sense that a large proportion of unqualified or lower qualified teachers find themselves at the lower end of the teacher salary distribution. In African countries experiencing low and negative economic growth in the 1980s, the academic qualifications of teachers decreased – the result perhaps of students moving into teaching from higher education as this required lower levels of financial investment (Mehrotra & Buckland, 2001: 4570).

Although evidence of a positive relationship between teacher remuneration and student performance does exist, the conclusion that the two are positively correlated is tentative at best. An important element to consider in investigating teacher remuneration is the profile of earnings over an individual's lifetime. If high quality teachers enter the profession, then what incentives exist for them to remain in teaching? Highly productive, dedicated and hard-working individuals are attractive in multiple occupations and so individuals must consider the opportunity cost of teaching when they decide whether to enter the teaching profession. Having entered teaching, the incentive to *remain* in the profession is a function of how earnings are expected to change over the teacher's lifetime. An attractive incentive then to enter the teaching profession would be an age-wage profile that offers wage growth comparable to or higher than that offered in other professions.

Evidence exists therefore that improving teacher remuneration or teachers' relative position in the income distribution may improve student performance.

[5] The authors make use of PISA data from 2000, 2003 and 2006 and TIMSS data from 1995, 1999 and 2005.
[6] The authors admit that they were unable to construct a consistent home background measure across countries (Dolton & Marcenaro-Gutierrez, 2011: 20) – a noteworthy omission in any analysis of student outcomes given the importance of family background in student performance.

3. Wage analysis[7]

Hernani-Limarino (2005:65) points out that arguably the most important determinant of the recruitment, performance and retention of effective teachers is whether or not they are well-paid. He points out, however, that although wages are the central point of the employment contract, there are important aspects of employment aside from wages that determine the attractiveness of a job. It is argued that the recruitment, performance and retention of teachers are directly related to the opportunity cost of being a teacher and that in most cases, the opportunity cost of being a teacher is restricted to the wage that an individual entering the teaching profession might have received in a profession other than teaching. However, this idea of the opportunity cost of teaching ignores some very important factors that may impact on how individuals perform their role as teachers, the incentives that teachers face to perform well and, importantly, the probability that well-performing teachers (and high-ability individuals) will remain in the teaching profession.

Some of the characteristics of employment that affect its attractiveness include the hours individuals are expected to work in a particular job, the stability of the job, and the flexibility of schedules and non-monetary benefits (such as in-kind payments and holidays) that may not be easily captured by survey data collection (Hernani-Limarino, 2005: 66). However, as we broaden the definition of the opportunity cost of being a teacher, we also increase the information requirement regarding the non-wage aspects of the labour contract, and although this information is useful and contributes to our understanding of the attractiveness of the teaching profession, it complicates the analysis somewhat. The difficulties involved with the assignment of values to non-monetary benefits and other employment characteristics may lead to inaccuracies in the calculation of teaching's opportunity cost.

For that reason, the analysis conducted in this section focuses primarily on the wage aspect of teaching in comparison to other professions.

This section makes use of data from the March and September rounds of the Labour Force Surveys (LFS) from 2000 to 2007, as well as the Quarterly Labour Force Survey (QLFS) of 2010. Earnings data were not collected for the 2008 and 2009 versions of the QLFS, hence the

[7]The fact that earnings data in the Labour Force Survey (to be used in this paper) is self-reported introduces potential for bias. In order to measure the potential bias in the self-reported earnings data, a brief analysis of the possibility of underreporting of wages by teachers using Persal payroll data is presented in Appendix A. It is impossible to ascertain whether under-reporting differs across different groups of workers, however.

two year gap between the surveys which are used in this analysis. Furthermore, earnings data were only collected in one quarter of the QLFS, so the sample for 2010 is significantly smaller than what is available for the 2000 to 2007 LFSs. The analysis is conducted only for employed workers in the South African labour market. Workers reporting real monthly earnings in excess of R200 000, workers employed in the informal and agricultural sectors, domestic workers and the self-employed are excluded from the analysis.

The absence of wage data in 2008 and 2009 is problematic for an analysis of teacher wages. It is impossible to ascertain whether any wage movements particular to the teaching profession occurred in those years and as the results show, it appears that significant changes in the age-wage profile for teachers took place between 2007 and 2010.

Real hourly wages are used throughout the analysis. Hourly wages are calculated by dividing the reported monthly wage by the number of hours workers reported working in a week multiplied by four. The number of hours worked by teachers is a point of contention, and the major issues that arise in relation to teachers' working hours are largely to do with the fact that a considerable portion of teachers' work takes place outside of official school hours. For example, marking and preparation often require that teachers work a considerable number of hours after official working hours. Important to bear in mind then is that unclear first of all whether the number of hours reported by teachers are their official working hours or the number of hours they actually worked, and second of all whether the calculated hourly wage for teachers accurately captures their remuneration on an hourly basis.

The analysis is conducted using real wages. Real values were calculated using a CPI deflator with 2000 as the base year. It is important to note that earnings captured in 2010 are implausibly high, even when deflated to 2000 prices.[8] This is apparent in the constant term observed in table 4 below.

Table 1 below presents the number of teachers and non-teachers[9] in the data, by year.

[8] Inconsistencies are observed amongst respondent in the 2010 QLFS (Q3) who reported the actual amount of their earnings as well as the income category into which their earnings fell. For example, respondents reporting that they earned R5 000 per month also reported that their earnings interval was R8 001 to R11 000. 19.92% of earners reported both the actual amount they earned as well as the income category into which their income fell. Stats SA has never clarified why this is the case.

[9] Table 1 presents the number of all non-teacher workers, including non-teaching professionals. For 2000 to 2007, the totals presented in table 1 are pooled across the March and September release of the LFS. For 2010, wage data was only made available in one quarter of the QLFS. There, the totals presented for 2010 are from one quarter of 2010 only.

TABLE 1: Number of teachers and non-teachers

Year	Teachers	Non-Teachers	Percentage of Sample that are Teachers	Total
2000	606 791	14 375 968	4.05	14 982 759
2001	612 438	14 618 009	4.02	15 230 447
2002	639 828	14 537 369	4.22	15 177 197
2003	853 307	14 505 334	5.56	15 358 641
2004	846 808	14 745 809	5.43	15 592 617
2005	880 953	15 498 690	5.38	16 379 643
2006	853 247	16 271 182	4.98	17 124 429
2007	946 320	16 961 273	5.28	17 907 593
2010	403 554	7 932 889	4.84	8 336 443

Source: LFS 2000-2007

Data for the years 2000 to 2007 are pooled for the sake of succinctness. Individual models run for each of these years reveal only very slight differences in the results obtained, suggesting similar data generating processes across these year. The variables included in the Mincerian wage function are presented in Appendix A, along with a table containing their summary statistics.

The summary statistics indicate that teachers have acquired higher levels of education than their counterparts in non-teaching professions. The values of experience (and therefore experience squared) are almost identical for the two groups and some 76 percent of teachers are union members compared to just 27 percent of non-teachers. The teaching force is considerably more female than non-teaching professions, with 64 percent of teachers being female versus just 41 percent in the non-teaching professions. Teachers have on average also remained with the same employer for longer than have non-teachers, with teachers having an average tenure of 11.68 years in comparison to 7.10 years for non-teachers. In terms of the racial composition of the two groups for which data are presented, the black and Indian component is almost identical for both teachers and non-teachers, the coloured component has more non-teachers than teachers (11 percent of non-teachers are coloured compared to 6 percent of teachers), and the white component has more teachers than non-teachers (24 percent of teachers are white versus just 16 percent of the non-teachers).

With the exception of the wage simulations presented in subsection 3.3, the analysis in this chapter is conducted for workers with at least 12 years of education. It compares teachers to all non-teachers in the labour market, as well as to non-teaching professionals. Teachers are defined as teaching professionals and associate teaching professionals in primary and secondary schools. Specifically, the group includes primary education teaching professionals and associate professionals and secondary education teaching professionals and associate professionals.

A list of non-teaching professionals, as defined in the LFS and QLFS, is presented in table A3 in Appendix A.

3.1 Wage Differentials

In order to determine whether or not teachers are well-paid, one possibility is to investigate the wages that teachers receive relative to the wages that they might have received in non-teaching professions. The gross (unadjusted) wage differential is a very basic measure of this relationship and reflects differences in wages that result from differences in both the remuneration structures for teachers and non-teachers, as well as differences in the productive endowments of members of both groups (Hernani-Limarino, 2005:68-71). The gross wage differential is calculated as

$$G_{TN} = \left(\frac{\overline{W}_T}{\overline{W}_N}\right) - 1 \qquad \textbf{(1)}$$

where $\overline{W}_T$ is the mean hourly wage of teacher and $\overline{W}_N$ is the mean hourly wage of non-teachers. Equation 1 is approximately equal to the mean log wage differential:

$$G_{TN} \approx \ln(G_{TN} + 1) = \ln(\overline{W}_T) - \ln(\overline{W}_N) \qquad \textbf{(2)}$$

In order for the gross wage differential to provide any substantial meaning, the group to whom teachers are compared should share similar productive characteristics.

Under the assumption of competitive labour markets, wages are understood to reflect the marginal product of labour. Wages are therefore a function of the worker's productive characteristics and the returns that those characteristics fetch in the labour market. If we let $\overline{W}_{TO}$ and $\overline{W}_{NO}$ reflect the mean wages received by teachers and non-teachers, respectively, and if they both face the same return structure for their productive characteristics, then the mean ***productivity wage differential*** is given by

$$Q_{TN} = \left(\frac{\overline{W}_{TO}}{\overline{W}_{NO}}\right) - 1 \qquad \textbf{(3)}$$

Therefore, the part of the wage differential that can be attributed to differences in the structure of returns faced by teachers and non-teachers – the ***conditional mean wage differential*** – will be calculated by the difference between the gross mean wage differential and the productivity wage differential:

$$D_{TN} = \left[\left(\frac{\bar{W}_T}{\bar{W}_N}\right) - \left(\frac{\bar{W}_{TO}}{\bar{W}_{NO}}\right)\right] / \left(\frac{\bar{W}_{TO}}{\bar{W}_{NO}}\right) \quad \textbf{(4)}$$

It is therefore possible to decompose the gross wage differential into

$$\ln(G_{TN} + 1) = \ln(Q_{TN} + 1) + \ln(D_{TN} + 1) \quad \textbf{(5)}$$

In other words, it is possible to decompose the gross wage differential into a part that is explained by differences in productive characteristics and a part that is explained by differences in the way that productive characteristics are remunerated for teachers and non-teachers.

Table 2 presents wage differentials for teachers and non-teachers and for teachers and non-teaching professionals, respectively.

TABLE 2: Wage differentials between teachers, non-teachers and non-teaching professionals (2000–2007 and 2010)

	Gross gap (1)		**Productivity gap (2)**		**Conditional gap (3)**	
	2000-2007	**2010**	**2000-2007**	**2010**	**2000-2007**	**2010**
Teachers and non-teachers	1.41	0.97	0.59	0.54	0.52	0.28
Teachers and non-teaching professionals	-0.30	-0.13	-0.02	0.08	-0.28	-0.19

Source: Own calculations from LFS (March and September) 2000 –2007 and QLFS (2020), Stats SA

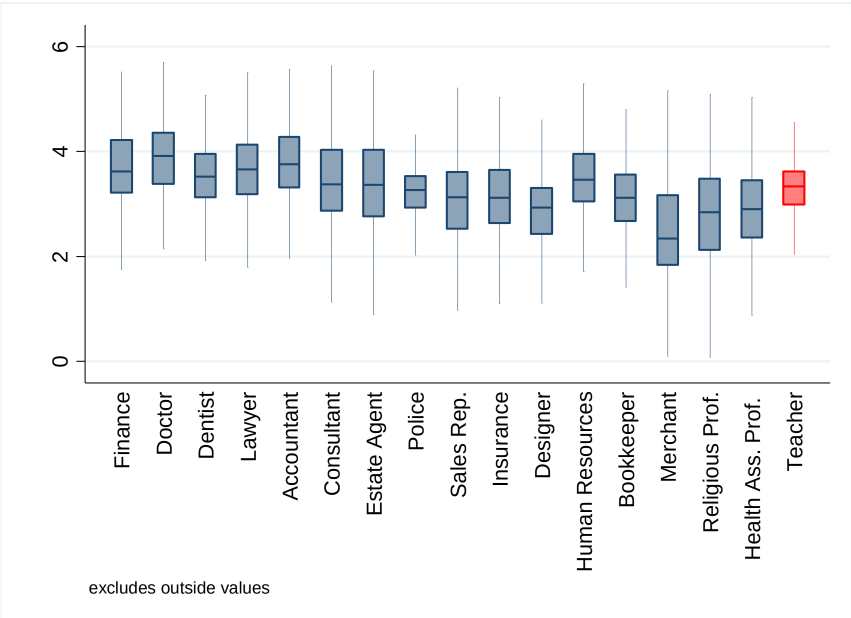
From table 2 we see that wage differentials favour teachers when compared to all non-teachers in the South African labour market. However, when teachers are compared to non-teaching professionals, teachers perform worse for most measures of wage differentials. As explained earlier, the conditional gap represents the portion of the overall wage differential that is attributable to differences in the remuneration structures faced by teachers and non-teachers. The negative conditional gap in favour of non-teaching professionals suggests that these professionals face a more attractive remuneration structure in the sense that the remuneration they receive for their productive characteristics are higher than those received by teachers.

Comparing teachers to all other non-teachers, we observe a positive wage gap that favours teachers, which is associated with the higher levels of human capital endowment amongst teachers relative to this larger sample (of non-teachers, rather than non-teaching professionals).

The negative productivity gap relative to non-teaching professionals for the 2000 to 2007 sample is associated with the observation that non-teaching professionals are in fact better endowed in terms of human capital than their teaching counterparts. This appears to reverse in favour of teachers in 2010.

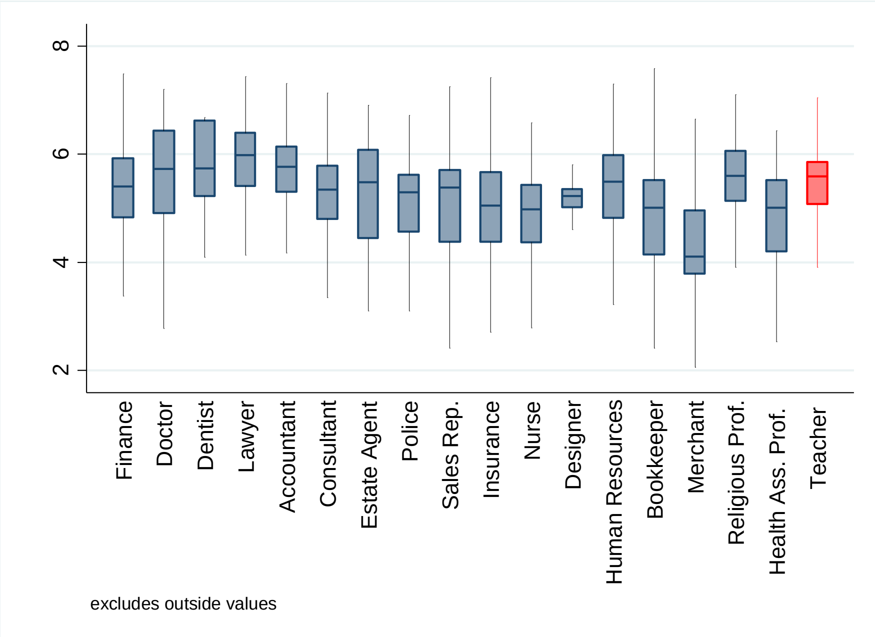
While examining wage differentials is useful to understand what is happening at the mean, it may also be useful to investigate how the distribution of teacher wages compares to that of non-teachers in the labour market. Following Gustafsson and Patel (2009:14), boxplots for real hourly wages have been plotted for teachers and some non-teaching professionals, allowing for an (admittedly superficial) investigation into how teachers' earnings compare with those of others in the labour market. Figures 1 and 2 present the boxplots for the 2000 to 2007 period and for 2010, respectively.

FIGURE 1: Boxplots of log real hourly wage (2000–2007)



Source: Own calculations from LFS (March and September) 2000–2007, Stats SA

FIGURE 2: Boxplots of log real hourly wage (2010)



Source: Own calculations from QLFS 2010, Stats SA

It is interesting to observe that in the 2000 to 2007 data, the range of real hourly wages for teachers is largely comparable to what may be thought of as "lower order" professions. In comparison to professions that are considered "prestigious" in the South African context (and largely internationally, too), teachers' hourly wage rate is slightly lower. We also see that the range of wages for teachers is narrower than it is for most other professions, highlighting the absence of large wage returns in the teaching profession. Again with the exception of individuals employed in the police force, merchants and potentially designers, teachers being paid the greatest wage on an hourly basis (excluding outliers) still receive hourly wages below that of all other professions included in the figure.

The picture is similar for 2010, the range of teacher wages appearing to be smaller than those for most other professions included in the analysis. The position of teachers relative to non-teaching professionals in the labour market remains more or less unchanged.

Boxplots comparing the annual earnings of teachers with those of other professionals are presented in Appendix A. Figures A1 and A2 indicate that the annual earnings of teachers are largely in in line with those of a lower tier of professionals, such as nurses as opposed to a higher tier of professionals such as accountants, doctors and lawyers.

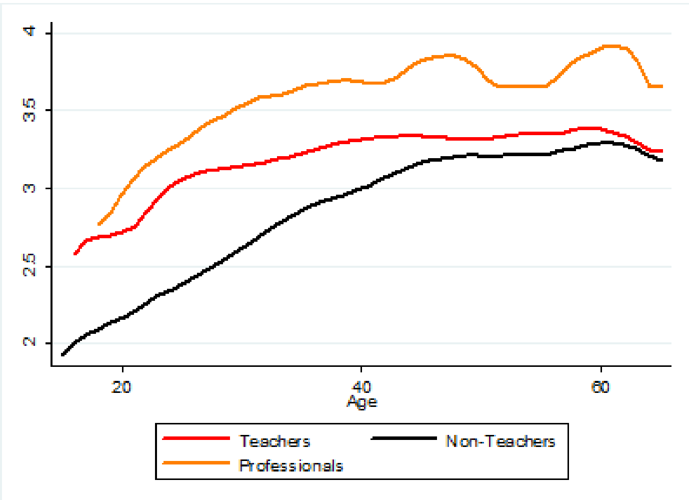
This raises the question of who *should* teachers be compared to when we try to find out whether or not teachers receive adequate pay. How would teachers classify themselves in terms of where they are positioned on the spectrum of professionals, and is this reflected in the remuneration structure they experience? It seems likely that teachers compare themselves to other professionals in terms of remuneration, given their level of education.

In order to compare the remuneration structure of teachers with that of non-teaching professionals in the South African labour market, the analysis is extended to investigate the returns to labour market characteristics. This is done in the following subsections.

3.2 Local polynomial smoothed lines

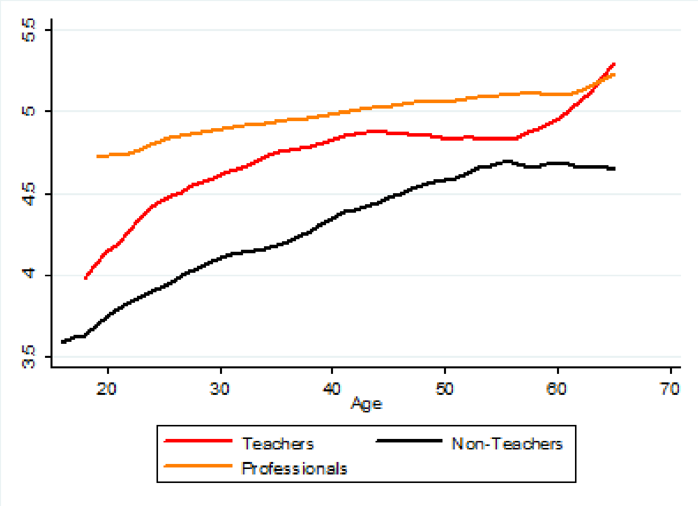
The local polynomial smoothed line is a line fitted to the data using weighted least squares. More weight is given to the points nearest to the point for which the response is being estimated, with points further away from that point receiving less weight. Such a local polynomial therefore enables us to observe the relationship between experience and wages without imposing any functional form on it, so we can see whether or not the remuneration structure of teachers is fundamentally different to that of non-teachers and non-teaching professionals. Figures 3 and 4 present the local polynomial smoothed lines for the relationship between wages and age – the age-wage profile – for the pooled 2000 to 2007 dataset and for the 2010 data, respectively.

FIGURE 3: Local polynomial smoothed lines for age-wage profile (2000–2007)



Source: Own calculations from LFS (March and September) 2000–2007, Stats SA

FIGURE 4: Local polynomial smoothed lines for age-wage profile (2010)



Source: Own calculations from QLFS (March and September) 2000–2007, Stats SA

The age-wage profile for teachers in the 2000 to 2007 data indicate that after age 40, returns to age appear to flatten out. This appears to be the case for all groups of workers in the economy and not exclusively for teachers. However, even when the returns to age are increasing for teachers, the slope of the profile in figure 3 indicates that it is increasing at a slower rate than is the case for non-teachers and non-teaching professionals. Figure 4 shows quite a different story for teachers in 2010. The slope of the age-wage profiles is steeper for teachers over most of the age range, flattening over the rage of roughly 42 to 55 years of age, and then increasing rapidly again thereafter. It therefore appears that in terms of returns to experience, the situation for teachers has improved somewhat in terms of the relationship between age and earnings.

Local polynomial smoothed lines are useful to look at the shape of the age-wage profile across different groups of workers. However, they are purely descriptive and do not control for differences in characteristics across different groups of workers. Multivariate analysis is required in order to isolate the effect of different productive characteristics on wages. This is conducted using Mincerian wage functions in section 3.3.

3.3 Mincerian wage functions

The Mincerian wage function investigates the return to productive characteristics in the labour market (namely educational attainment and potential labour market experience) and takes the form

$$\log of\ hourly\ wage = \beta_1(13\ years\ of\ Education) + \beta_2(15\ years\ of\ Education) + \beta_3(16\ years\ of\ education) + \beta_4(17\ years\ of\ Education) + \beta_5(\ teacher\ x\ 13\ years\ of\ education) + \beta_6(teacher\ x\ 15\ years\ of\ education) + \beta_7(teacher\ x\ 16\ years\ of\ education) + \beta_8(teacher\ x\ 17\ years\ of\ education) + \beta_9(years\ of\ potential\ experience) + \beta_{10}(year\ of\ potential\ experience^2) + \beta_{11}(teacher\ x\ years\ of\ potential\ experience) + \beta_{12}(teacher\ x\ years\ of\ potential\ experience^2) + \delta X + e \quad \textbf{(6)}$$

in which β_1 to β_{12} indicate the impact that education, experience and its squared term have on hourly wages as well as whether this differs between teachers and non-teachers in the South African labour market. X is a vector of worker characteristics[10], and δ is a vector of the impact that these characteristics have on the log of hourly wages.

Table 3 presents the coefficient obtained for regressions run for pooled data for all the years between 2000 and 2007 (column 1), and for 2000, 2007, and 2010 (columns 2, 3 and 4 respectively).

TABLE 3: Regression estimates for augmented Mincerian wage function on log hourly wages (2000–2007 and 2010[11])

VARIABLE	2000 – 2007 (1)	2000 (2)	2007 (3)	2010 (4)
13 yrs education	0.530*** (0.006)	0.478** (0.023)	0.631*** (0.016)	0.335*** (0.007)
15 yrs education	0.907*** (0.009)	0.803*** (0.031)	1.080*** (0.025)	0.472*** (0.011)
16 yrs education	1.053*** (0.012)	1.059*** (0.043)	1.390*** (0.030)	0.568*** (0.018)
17 yrs education	1.227*** (0.027)	-	1.383*** (0.050)	0.582*** (0.020)
13 yrs education x teacher	-0.139*** (0.032)	-0.145 (0.119)	-0.104 (0.079)	-0.137*** (0.035)

[10] These characteristics include race, sex, marital status, the industry in which workers are employed and the province in which they are employed.

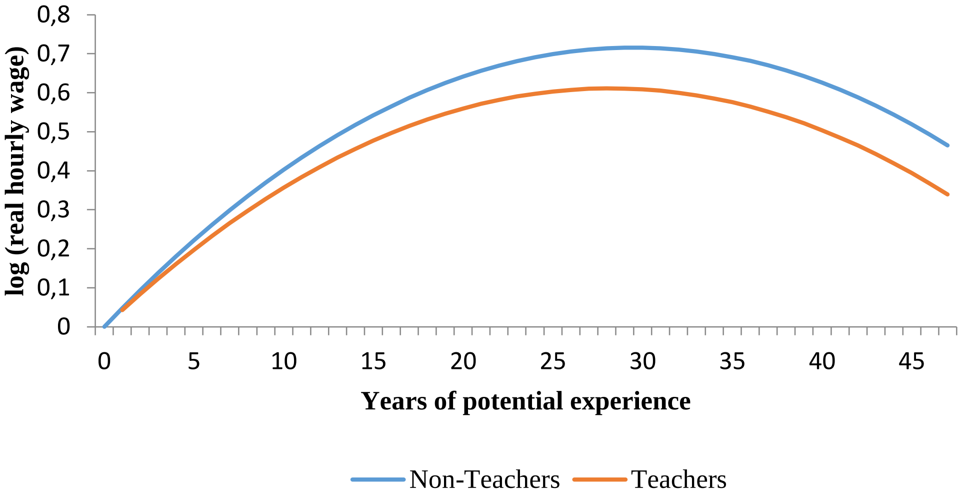
15 yrs education x teacher	-0.417***	-0.328**	-0.357***	-0.242***
	(0.035)	(0.128)	(0.089)	(0.039)
16 yrs education x teacher	-0.562***	-0.817***	-0.651***	-0.288***
	(0.037)	(0.136)	(0.091)	(0.048)
17 yrs education x teacher	-1.183***		-0.680***	-0.532***
	(0.089)	-	(0.192)	(0.070)
experience	0.045***	0.048***	0.033***	0.011***
	(0.001)	(0.003)	(0.003)	(0.001)
experience squared	-0.001***	-0.001***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
experience x teacher	0.005	-0.005	0.013	0.014***
	(0.004)	(0.013)	(0.010)	(0.005)
experience squared x teacher	0.000***	0.000	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
female	-0.164***	-0.197***	-0.150***	-0.109***
	(0.005)	(0.018)	(0.013)	(0.006)
married	0.153***	0.153***	0.155***	0.076***
	(0.005)	(0.020)	(0.014)	(0.006)
teacher	0.338***	0.425**	0.108	0.074
	(0.047)	(0.165)	(0.096)	(0.054)
constant	1.174***	1.229***	1.403***	2.782***
	(0.020)	(0.069)	(0.053)	(0.100)
Adjusted R-Squared	0.440	0.402	0.510	0.344
No. of Observations	105 897	8 340	15 033	28 860

*Source: Own calculations from LFS (March and September) 2000–2007 and QLFS 2010, Stats SA. Race, province, year and industry are controlled for in these regressions. Standard errors are reported in parentheses. *, ** and *** indicate that coefficients are significant at a 10%, 5% and 1% level, respectively.*

The results in table 3 present important information in terms of the productive characteristics of teachers and how they are remunerated in the labour market. The regressions are run for workers with more than 12 years of education and education dummies are included for workers with 13, 15, 16 and 17 years of education. The education dummies are then interacted with a dummy variable taking a value of 1 for teachers and 0 otherwise, in order to indicate whether returns to education differ significantly for teachers in comparison to non-teachers. The same is done for experience and its squared term in order to investigate whether the returns to labour market experience differ for teachers and non-teachers. In terms of labour market returns to education, table 3 indicates that teachers are initially better remunerated than the non-teachers investigated here at relatively low levels of education and experience, but that these gaps decrease with higher levels of education, as reflected in the negative and coefficients for interaction effects that grows in size with more education. This highlights the fact that in terms of returns to educational attainment, the teaching profession is least attractive to individuals with higher levels of education. The size of the negative teacher effect remains fairly stable across time.

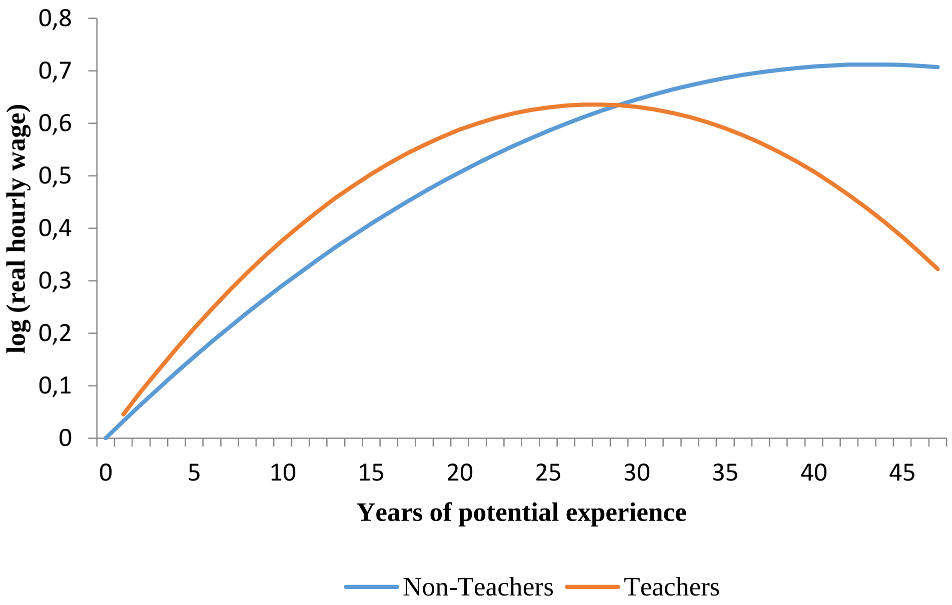
In terms of the returns to experience for teachers versus non-teachers, the quadratic term introduced to account for possible non-linearities makes it difficult to interpret the effect of experience on earnings by simply analysing the coefficients. The returns to experience have therefore been graphed for the results obtained in columns 2, 3 and 4 in figures 5, 6 and 7 respectively.

FIGURE 5: Returns to potential experience (2000)



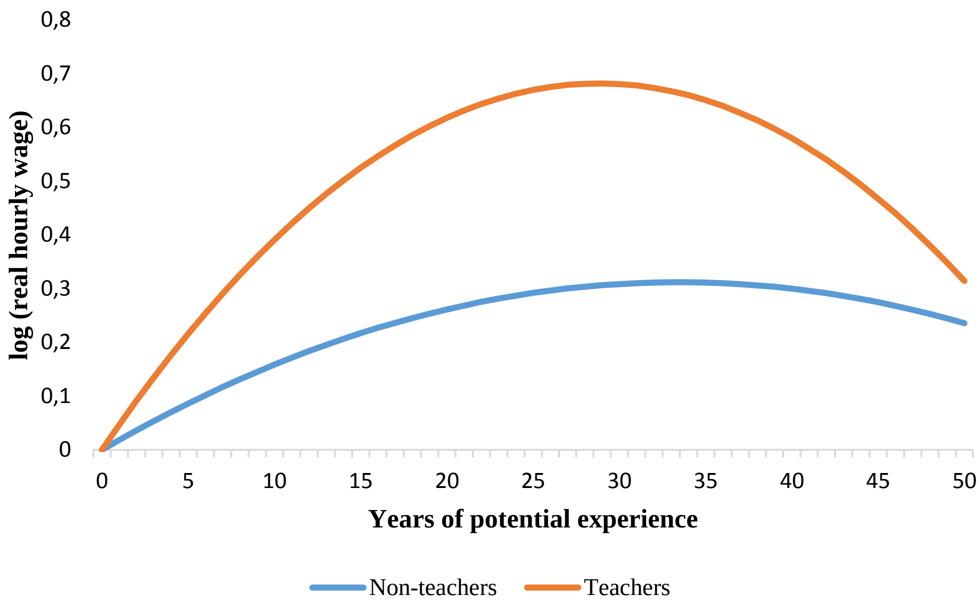
Source: Own calculations from LFS (March and September) 2000–2007 Stats SA

FIGURE 6: Returns to potential experience (2007)



Source: Own calculations from LFS (March and September) 2000–2007 Stats SA

FIGURE 7: Returns to potential Experience (2010)

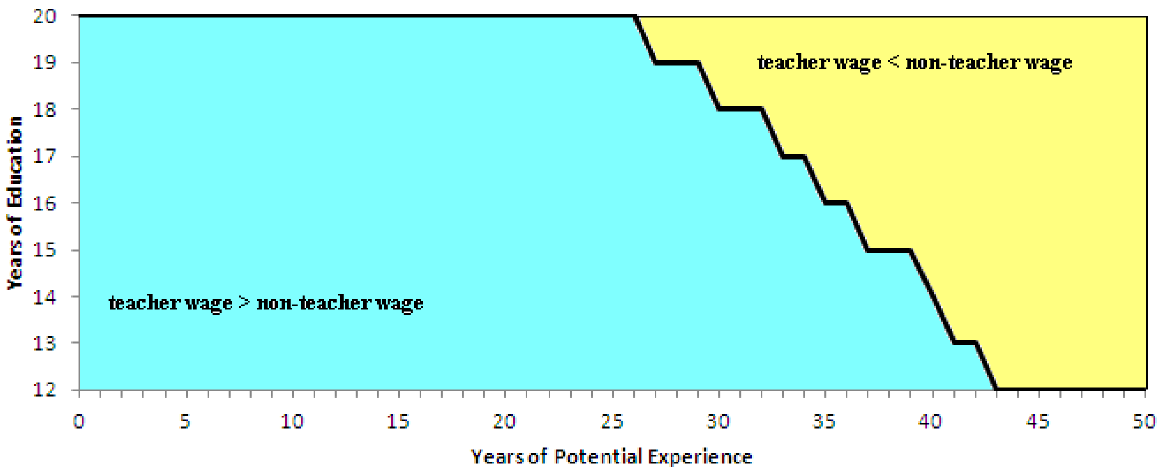


Source: Own calculations from QLFS 2010, Stats SA

The figures illustrate the relative flatness of the experience profiles for members of the teaching profession in comparison to those of non-teachers. In 2000 the returns to experience for teachers are below those of non-teachers at all levels of experience, and the teacher disadvantage appears to grow at higher levels of experience. In 2007, the returns to experience amongst teachers are higher than amongst their non-teaching counterparts until roughly 28 years of labour market experience, after which they decrease rapidly. Interestingly, it appears that in 2010 the difference between teachers and non-teachers in terms of returns to experience is in favour of teachers at all levels of experience. However, after 25 years of experience returns for teachers start to decrease, therefore narrowing the gap between the groups. A steeper gradient on the profile indicates that teacher pay increases at a faster rate as teachers gain more experience, but also that the returns to experience amongst teachers fall considerably faster than those of non-teachers at higher levels of education. Yet, returns to experience for teachers across all levels of experience are higher than they are for non-teachers. This suggest that despite evidence of little incentive in earlier years (i.e. 2000 to 2007) for teachers to remain in the teaching profession after a certain level of experience has been attained, it appears that returns to experience for teachers may have improved over the period 2008 to 2010.

An attempt to compare the attractiveness of wages for teachers and non-teachers across the range of educational attainment and potential experience is presented with a "profile" of teacher and non-teacher earnings drawn for different combinations of education and experience.[12] This profile is drawn for the entire labour force, regardless of their level of educational attainment, as well as for individuals with at least 10 years of education. For this analysis, 10 years of education is chosen as this is the lowest level of educational attainment observed amongst teachers in the dataset. The objective is to analyse the level of education and experience at which teacher wages become more or less attractive, at the mean. The area shaded blue indicates the levels of education and experience at which teacher wages exceed those of non-teachers, while the area shaded yellow represents the levels of education and experience at which non-teacher wages exceed those of teachers. The profiles are presented in figures 8 and 9.

FIGURE 8: Wage differential between teachers and non-teachers (2000–2007)



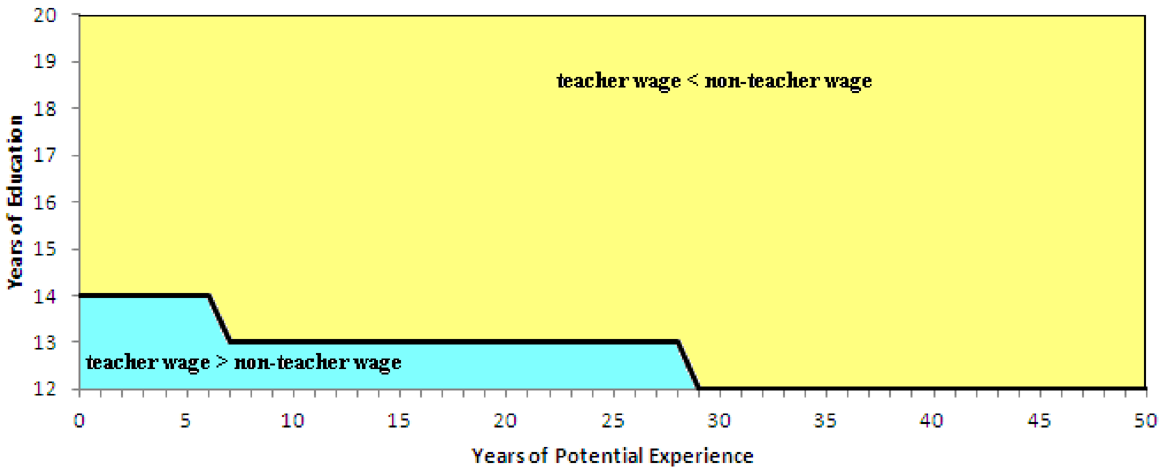
Source: Own calculations from LFS (March and September) 2000–2007 Stats SA

From figure 8 it may be seen that until 25 years of labour market experience, teacher wages are higher than those of non-teachers in the South African labour market for all levels of educational attainment. After 25 years of labour market experience, the wages of non-teachers become incrementally more attractive at higher levels of labour market experience. This

[12] The coefficients of the Mincerian wage function for which these profiles are drawn is presented in Table A4 in Appendix A. Figures 8 and 9 are drawn using only the coefficients for *Education, Experience* and *Experience*^{2}.

provides evidence of the unattractiveness of the age-wage profile in terms of returns to experience for the teaching profession while also highlighting the attractiveness of the profession for younger labour market participants.

FIGURE 9: Wage differential between teachers and non-teachers with at least 10 years of education (2000–2007)



Source: Own calculations from LFS (March and September) 2000–2007 Stats SA

Figure 9 presents the profile for non-teachers with a minimum of ten years of educational attainment, therefore comparing teachers to a more educated sample of workers in the South African labour market. It is clear that for individuals with more than 14 years of education, teacher remuneration is never more attractive than that received by non-teachers (in terms of returns to productive characteristics), regardless of the level of labour market experience. For individuals with 14 years of education, the teaching profession is more attractive than non-teaching professions only for the first 6 years in the labour market, while for workers with 13 years of education the teaching profession remains more attractive until 28 years of labour market experience.

Figures 8 and 9 illustrate the relative unattractiveness of the teaching profession for workers with higher levels of education. We can see that in figure 9, drawn for a more educated sample of non-teachers, the teaching profession is almost always less attractive than non-teaching professions, while in figure 8 it is only at higher levels of labour market experience that the teaching profession becomes less attractive.

The analysis so far has highlighted the fact that teachers' productive characteristics are not rewarded as attractively as those of non-teachers in the labour market. What if teachers' productive characteristics were remunerated in the same way as those of non-teachers? Would the distribution of teacher wages be higher or lower than that of their non-teaching counterparts? This is investigated using a Lemieux decomposition.

3.4 Lemieux decomposition

This decomposition technique is used to create a counterfactual wage distribution for teachers and non-teachers in the South African labour force. The Lemieux decomposition used in this paper may be understood to be a generalization of the decomposition technique first introduced by Oaxaca and Blinder in 1973 (Lemieux, 2002). The Oaxaca-Blinder decomposition decomposes the difference in the mean wage between two groups into the component explained by differences in productive characteristics and into an "unexplained" component (i.e. a component resulting from differences in how productive characteristics are remunerated between the two groups in question, or "discrimination").

Decomposing the wage gap at the mean involves estimating the Ordinary Least Squares (OLS) wage regression

$$y_{it} = b_t x_{it} + u_{it} \qquad \textbf{(7)}$$

where y_{it} is the log hourly wage of individual i belonging to group t (in this case to the group *teachers*), x_{it} is a vector of covariates, b_t is a vector of parameters and u_{it} is an error term constructed to have a mean of 0 and to be uncorrelated with the covariates in the vector x_{it} (Lemieux, 2002). The sample average outcome y for teachers is therefore

$$\bar{y}_t = \bar{x}_t b_t \qquad \textbf{(8)}$$

where $\bar{y}_t = \sum_1 \omega_{it} \, y_{it}$

and $\bar{x_t} = \sum_1 \omega_{it} \, x_{it}$.

The outcome for individuals belonging to the second group in the sample (in this case non-teachers) is estimated by

$$y_{in} = b_t x_{in} + u_{in} \qquad \textbf{(9)}$$

where y_{in} is the log hourly wage of individual i belonging to group n (i.e. non-teachers), x_{is} is a vector of covariates, b_s is vector of parameters and u_{is} is an error term constructed to have a mean of 0 and to be uncorrelated with the covariates in the vector x_{is}. The sample average outcome y for teachers is therefore

$$\bar{y}_n = \bar{x}_n b_n \tag{10}$$

where $\bar{y}_n = \sum_1 \omega_{in} \, y_{in}$

and $\bar{x}_t = \sum_1 \omega_{in} \, x_{in}$.

Calculating the difference between the mean outcomes of teachers and non-teachers therefore yields

$$\bar{y}_t - \bar{y}_n = \bar{x}_t \, (b_t - b_n) + b_n(\bar{x}_t - \bar{x}_n) \tag{11}$$

where $\bar{x}_t \, (b_t - b_n)$ is the difference in wages arising from differences in the remuneration structures faced by teachers and non-teachers (i.e. the “unexplained” component) and $b_n(\bar{x}_t - \bar{x}_n)$ is the difference in wages arising from differences in productive characteristics between teachers and non-teachers (Lemieux, 2002). $b_n\bar{x}_t$ may therefore be seen as the counterfactual mean value of *y* that would result if the remuneration structure of teachers was replaced with that of non-teachers. In other words, $b_n\bar{x}_t$ would be the wage prevalent for teachers if the “price” of human capital amongst teachers was equal to that experienced by non-teachers in the labour market.

The counterfactual wage for teachers is therefore

$$\bar{y}_t^a = \bar{x}_t b_n \tag{12}$$

which may be used to rewrite equation 12 as

$$\bar{y}_t - \bar{y}_n = (\bar{x}_t b_t - \bar{y}_t^a) + (\bar{y}_t^a - \bar{x}_n b_n) = (\bar{y}_t - \bar{y}_t^a) + (\bar{y}_t^a + \bar{y}_t).$$

Individual counterfactual wages are therefore denoted y_{it}^a and are calculated as

$$y_{it}^a = x_{it} \, b_n + u_{it} = y_{it} + x_{it}(b_s - b_t).$$

$\bar{y}_t^a$ may also be calculated by computing a sample mean of y_{it}^a:

$$\bar{y}_t^a = \sum_1 \omega_{it} \, y_{it.}^a \tag{13}$$

In order to estimate what the entire distribution of teacher wages would look like (as opposed to just the mean wage), the probit for the probability of being a teacher is estimated on the pooled sample of teachers and non-teachers. The probit model produces the probability of being a member of the teaching force conditional on individual worker characteristics, or individual xs.

$$P_{it} = Prob(teacher = 1 \mid x_{it}).$$

The reweighting function is then calculated using the estimated probability of being a teacher as

$$\Psi_i = \frac{[\frac{1-P_{it}}{P_{it}}]}{[\frac{P_t}{(1-P_t)}]}$$

where P_t is the unconditional probability of an observed worker being a member of the teaching force, or the weighted share of the pooled sample who are teachers (Lemieux, 2002). The reweighted distribution or the counterfactual distribution is therefore

$$y_t^a = \Psi(x_t b_n) = \Psi' y_n \qquad \textbf{(14)}$$

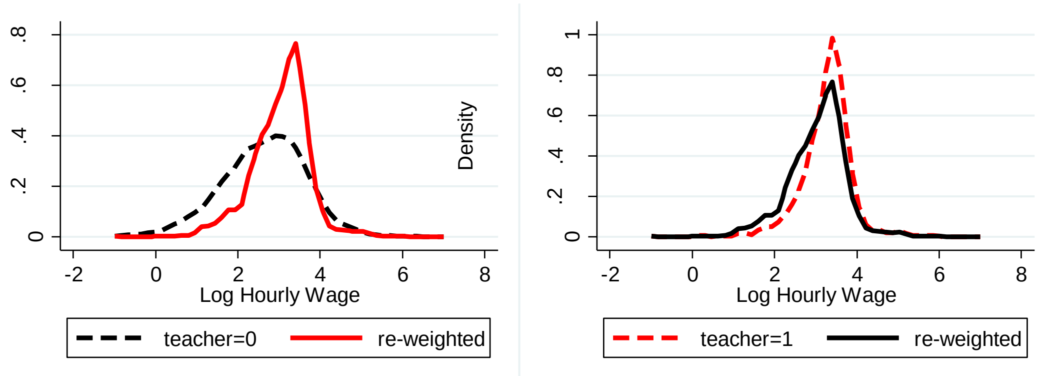
where $\Psi' = \frac{1}{\Psi}$ (Lemieux, 2002).

The decomposition has been used by various authors to investigate wage distributions across a number of countries. DiNardo, Fortin & Lemieux (1996) used a precursor to the method to investigate the impact of labour market and institutional factors on the distribution of wages in the US. These authors explain that the technique provides a “visually clear representation of where in the density of wages these various factors exert the greatest impact” (DiNardo et al, 1996: 1001). Using the technique, DiNardo et al (1996: 1009) are able to assess what wages would have looked like had particular factors taken on different values. “What would the density of wages have been in 1988 if workers’ attributes . . . remained at their 1979 level” (DiNardo et al, 1996: 1009). Shimizutani & Yokoyama (2009) analyse changes in the distribution of years of tenure in Japan’s long-term employment since the 1990s following a decade-long recession. The method is used because it allows for the decomposition of the changes into the part explained by changes in distribution of worker and firm attributes and the part explained by the effect of these attributes on workers’ tenure (Shimizutani & Yokoyama, 2009: 318). Shimizutani & Yokoyama (2009: 318) examine what the distribution of worker tenure would have been in 1995, 2000 and 2003 had worker and firm attributes remained at levels recorded in the 1990s.

In this study, the technique compares the labour market prospects of teachers to those of non-teachers in the South African labour market. The objective of the technique is investigate what the distribution of teacher wages would have looked like if they had the same productive characteristics as non-teachers or non-teaching professionals, and vice versa. Whereas the work of DiNardo et al (1996) and Shimizutani & Yokoyama (2009) create counterfactuals based on differences across time periods, the counterfactuals in this study are created across different groups of workers, namely teachers and non-teachers, or teachers and non-teaching professionals.

The results obtained for teachers and non-teachers using this composition are presented in figures 10 to 15 below.

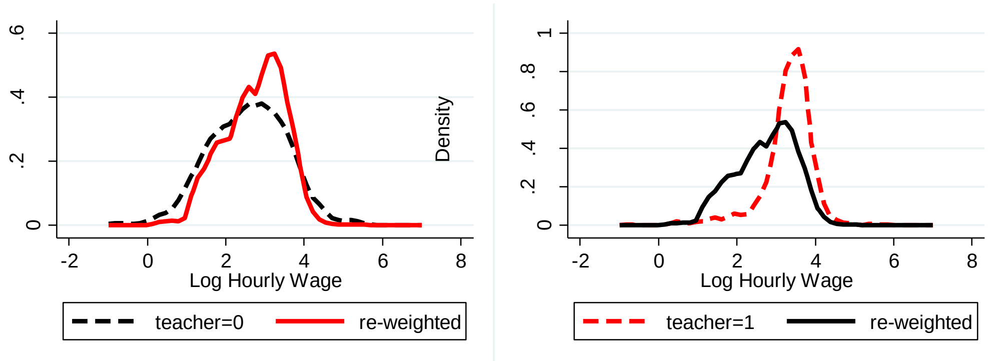
FIGURE 10: Teachers and non-teachers,[13] 2000



Source: LFS (March and September) 2000, Stats SA

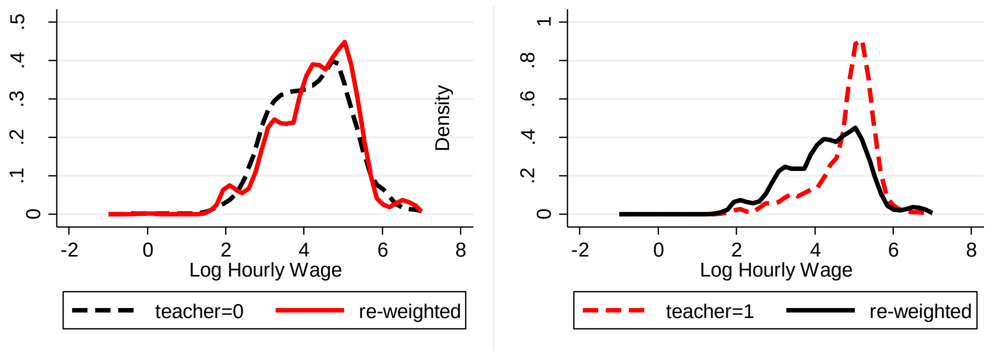
[13] At least 12 years of educational attainment

FIGURE 11: Teachers and non-teachers[14], 2007



Source: LFS (March and September) 2007, Stats SA

FIGURE 12: Teachers and non-teachers[15], 2010

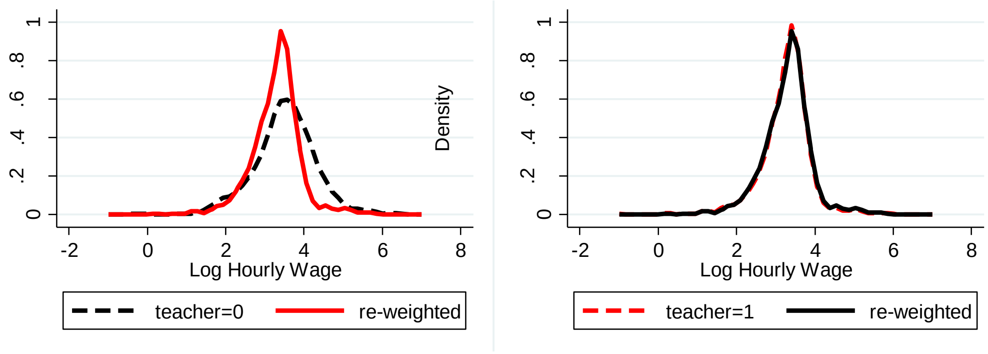


Source: QLFS 2010, Stats SA

Figures 10, 11 and 12 present re-weighted counterfactual distributions for teachers and all non-teachers in 2000, 2007 and 2010, respectively. All three figures illustrate that if teachers had been remunerated according to the same structure as that faced by non-teachers, the distribution of wages would lie to the left of where it currently lies. Importantly, the counterfactual distribution is based purely on productive characteristics, suggesting inferior endowments amongst teachers relative to non-teachers.

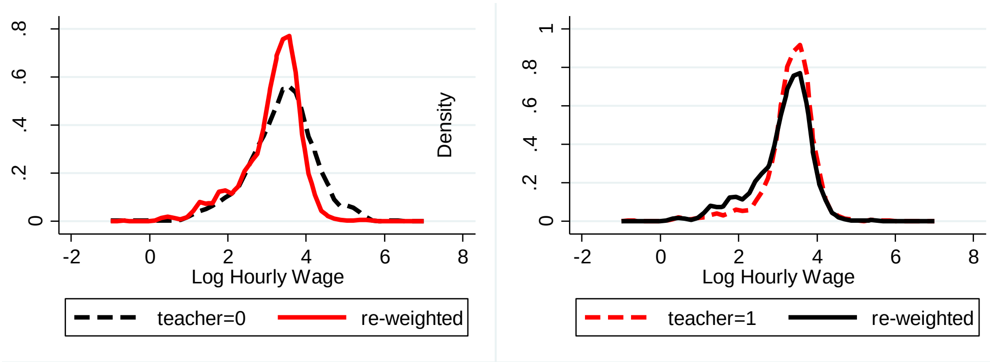
[14] At least 12 years of educational attainment
[15] At least 12 years of educational attainment

FIGURE 13: Teachers and non-teaching professionals, 2000



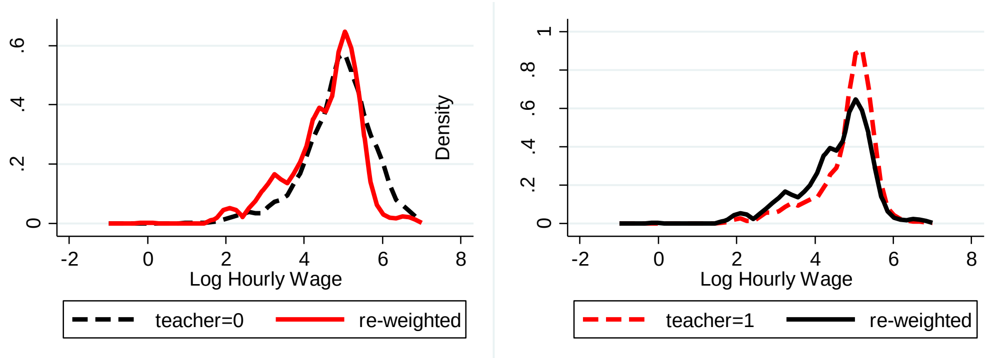
Source: LFS (March and September) 2000, Stats SA

FIGURE 14: Teachers and non-teaching professionals, 2007



Source: LFS (March and September) 2007, Stats SA

FIGURE 15: Teachers and non-teaching professionals, 2010



Source: QLFS 2010, Stats SA

Figures 13, 14 and 15 present the counterfactual distributions for teachers and non-teaching professionals. The left hand panel of the figures indicates that if non-teaching professionals, given their productive endowments, were remunerated according to the same structure as teachers, they would experience lower wages. If teachers, given their productive characteristics, were remunerated according to the salary structure of non-teachers in the South African labour market, they would experience a wage distribution that is roughly similar to their current structure, with the exception of the right panel in figure 13. From figure 13 it appears that had teachers been remunerated in 2010 according to the salary structure faced by non-teaching professionals, they would have received lower wages than what they received as teachers. This is an important observation, particularly when considered together with the local polynomial smoothed line presented for the age-wage profile faced by teachers in figure 4.

3.5 Conclusion

From the wage analysis above we can see that teacher wages are more similar to the wages of “lower order” professionals than they are to wages of individuals working in what might be considered “prestigious” professions. This is confirmed by the negative teacher premium for teachers when compared to non-teaching professionals. Furthermore, the level of returns to education and experience for teachers are considerably lower than they are for other professionals in the labour market.

So how does one interpret the results obtained in the wage analysis? The fact that teachers receive relatively unattractive remuneration in comparison to non-teaching professionals may be explained by various situations. Firstly, it may be the case that individuals who choose to become teachers may have higher preferences for the non-wage benefits implied by the teaching profession. For example, they may be attracted by the job security, shorter working hours or perhaps simply a love of children and the activity of teaching. A second possibility is the perception that private sector wages are likely to be driven by productivity, inducing individuals with lower levels of unobservable productivity to enter the teaching profession. Finally, we may find that impatient individuals enter the teaching force as a result of the fact that teaching yields higher returns earlier in the life cycle. If the second of these explanations is in fact driving individuals to enter the teaching force, we have reason for concern.

So who is entering the teaching force? Are individuals who choose to become teachers inherently less productive than those who choose other professions? Section 4 investigates whether there are differences in the "productive potential" of individuals training to become teachers compared to those who are educating themselves in a different direction. It makes use of data on the grade 12 performance of university entrants into different faculties.

4. Academic performance of future teachers

This section provides a brief analysis of the academic ability (as measured by performance in grade 12 exams) of students enrolled for first year studies in Education (Bachelor of Education, or BEd) and in other fields in one university. The overall objective is to ascertain whether or not a notable difference in performance is observed for BEd students in comparison to students enrolled in other degrees, and if so, how BEd students perform relative to other students.

4.1 Data

The data used for this analysis were obtained from the University of Stellenbosch and contain information on the grade 12 marks obtained for each subject written by students enrolled in first year programmes at the university. For the purpose of this analysis, first language and mathematics scores were used to gauge student performance and to assess the extent to which BEd students differed from others.

4.2 Performance across faculties

The proportion of students who took higher grade mathematics as a subject in grade 12 as well as mathematics and language performance in grade 12 are used as proxies for the academic ability of students entering university. In terms of handling differences in performance on the basis of higher grade (HG) and standard grade (SG), the marks of students who wrote standard grade mathematics were weighted down by 0.25. Simkins[16] (2010) explains that in terms of the National Senior Certificate (NSC) introduced in 2008, the department of education envisaged a mark of 40 percent for higher grade mathematics prior to 2008 to be equivalent to 50 per cent for the NSC mathematics. Similarly, a mark of 72 per cent for mathematics literacy was deemed equivalent to 50 per cent for mathematics under the National Senior Certificate.

Mathematics marks were therefore adjusted according to the following formulas:

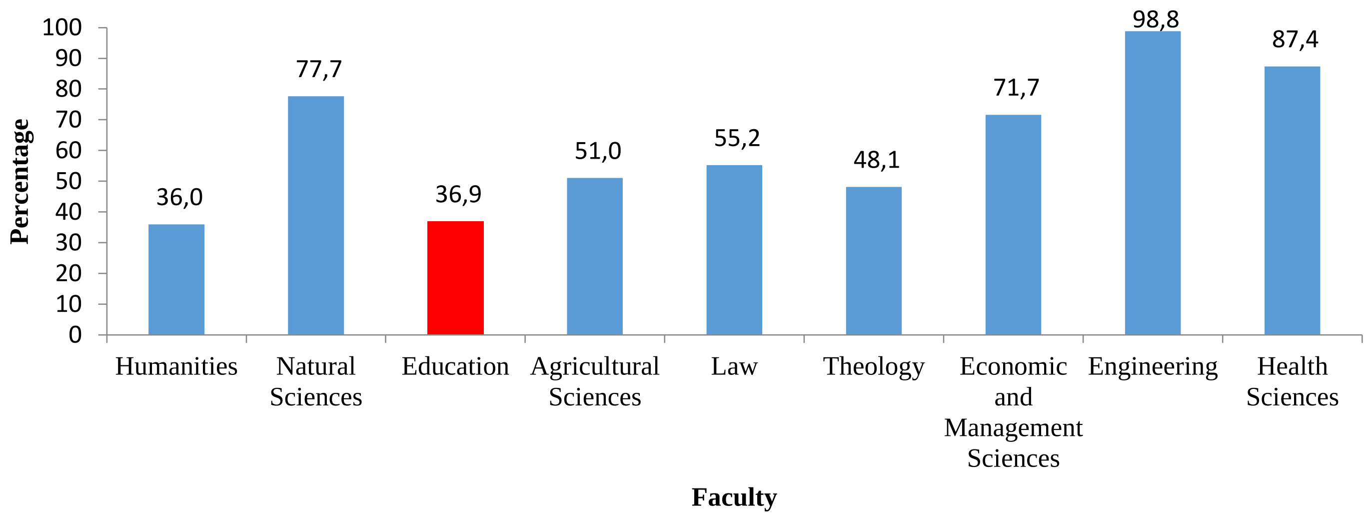
[16] Prof. Simkins was commissioned to conduct a study comparing the Senior Certificate exams written prior to 2008 and the National Certificate introduced in 2008.

- SG mathematics = 0.75 x HG mathematics
- NSC mathematics = 0.8 x HG mathematics
- Mathematics literacy = 0.44 x HG mathematics

For students who took more than one language as a first language, the mean language mark across the languages was calculated.

The proportion of students who took higher grade mathematics in grade 12 are presented in figures 16 for 2005, 2006 and 2007 combined. This is an admittedly crude measure of student ability.

FIGURE 16: Percentage of students who took higher grade mathematics, 2005-2007

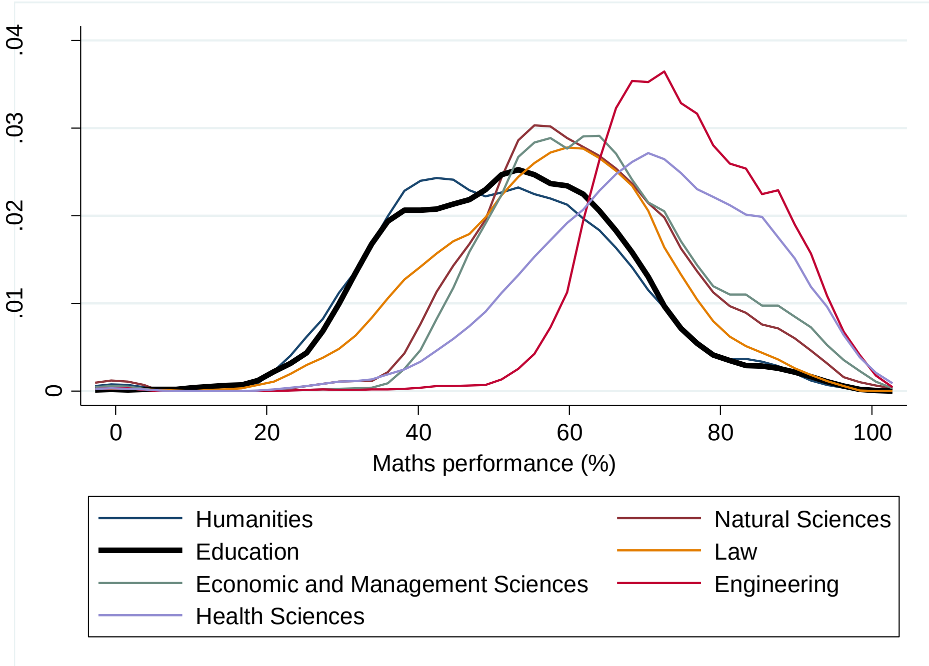


Source: Data for students enrolled at the University of Stellenbosch in first year programmes

From figure 16 it is observed that with the exception of the humanities faculty, the lowest proportion of students who wrote higher grade mathematics were those enrolled in the Faculty of Education. If we assume that higher-ability individuals are more likely to take higher grade mathematics than individuals with lower levels of ability, the data from figure 16 suggests the possibility of lower levels of academic ability amongst individuals enrolling for degrees in the Education Faculty.

An analysis of the distribution of marks for students enrolled in different faculties is presented in figure 17 and 18 for mathematics and language, respectively.

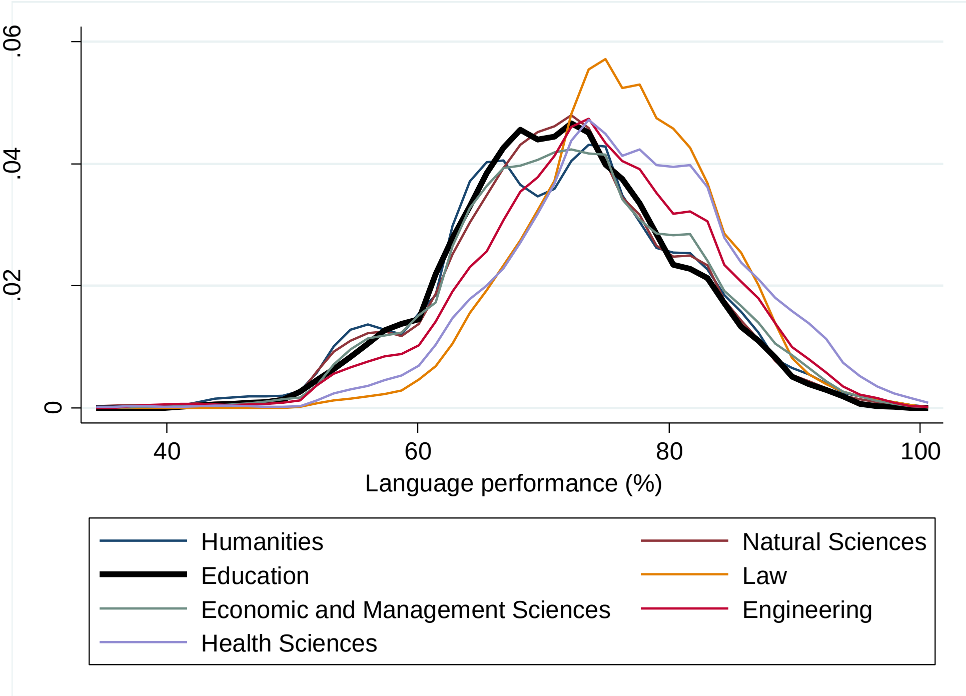
FIGURE 17: Performance in mathematics, 2005-2009



Source: Data for students enrolled at the University of Stellenbosch in first year programmes

Figure 17 shows that the distribution of mathematics marks for students enrolled in the Education Faculty lies to the left of the distributions for students enrolled in most of the other faculties. At higher levels of achievement (roughly 75 percent and upwards), the distribution of education students lies below that of all other students. Similarly, at low levels of achievement (40 percent and lower), the distribution of Education students lies above those of students enrolled in most other faculties (with the exception of Humanities, which shows very low levels of achievement), indicating that the maths performance of students enrolled in the Faculty of Education is weaker than that of students enrolled in other faculties. Figure 18 presents the distribution of marks for first language scores.

FIGURE 18: Performance in language, 2005-2009



Source: Data for students enrolled at the University of Stellenbosch in first year programmes

The distribution of marks for first language performance for Education students does not lie as far to the left as it does for mathematics. However, we see that the distribution for Education students at higher levels of achievement is below those of students enrolled in other faculties. The difference in performance does not appear to be as stark as it is for mathematics.

Some evidence exists of weaker academic performance amongst students enrolled in the Faculty of Education relative to students enrolled in other faculties. It must, however, be acknowledged that the data used to obtain this result came from one university. It is therefore questionable whether these results are applicable to other institutions or to South Africa as a whole. Yet it still suggests that it may well be individuals with lower levels of academic achievement who are entering the teaching force – a worrisome prospect for a country facing such low levels of educational performance.

5. Conclusion

This paper investigated the remuneration structure for teachers in the South African labour force and how this compares to that of non-teachers. In comparison to non-teaching professionals with higher levels of educational attainment, the remuneration structure of teachers is unattractive, but relative to all non-teachers in the South African labour market, the remuneration structure for teachers is more appealing. The wage profiles drawn in section 3 revealed that teacher wages are attractive to individuals with lower levels of educational attainment, with the profession becoming less attractive as individuals enhance their level of educational attainment and as labour market experience increases. A worrying aspect of teacher remuneration in South Africa is the flatness of the age-wage profiles faced by teachers. However, it appears as if this may be changing slowly, becoming comparable to what is observed for individuals employed in other professions, therefore potentially eroding some of the relative unattractiveness of the wage structure faced by teachers. In addition, Irving (2012: 394) explains that in South Africa's apartheid era, teaching was considered an opportunity for upward social mobility in a labour market context in which certain race groups were not allowed to enter other professions. In 1986, teacher salaries were equalized along racial and gender lines and teaching therefore became a very attractive choice of profession for black South Africans, particularly for black women, given the rapid rise in salaries (Irving, 2012: 394). However, since 1994 professional opportunities for black South Africans have expanded dramatically and skilled black South Africans qualified for positions from which they had been previously excluded. This is likely to have dramatically increased the opportunity cost of teaching relative to other professions (Irving, 2012: 394).

The brief analysis of the academic quality of students enrolled for first year studies at the University of Stellenbosch revealed that students enrolled in the Faculty of Education perform somewhat worse than their counterparts in other faculties in mathematics, and to a lesser degree in language, too. If we assume that wages are driven by productivity, then this may explain the relative unattractiveness of teachers' wage structure in comparison to that received by non-teaching professionals. Either way, the prospect is worrisome for the South African education system. Further research to ascertain what motivates individuals to become teachers would prove extremely useful in understanding who is drawn to the teaching profession, and potentially also how high-ability individuals can be attracted to the profession. The current remuneration structure relative to that of non-teaching professions seems unlikely on its own to ensure that top-ability individuals would follow a career in teaching.

Chapter 2

Teacher incentives in South Africa: A theoretical investigation of the possibilities

1. Introduction: Teacher quality in South Africa and the possibility of incentives

For the country's level of development and the proportion of the budget that is spent on education, South Africa performs substantially below what is expected of it in terms of educational performance (National Education Evaluation and Development Unit, 2012: 13). Performance amongst learners in this country is markedly worse that amongst learners in countries which are poorer than South Africa. In the third round of international tests conducted by the Southern African Consortium for the Measurement of Educational Quality (SACMEQ) in 2007, South Africa performed worse than most of the participating countries in both mathematics and language (Spaull, 2011a: 43), managing only to outperform Lesotho, Mozambique, Uganda, Malawi and Zambia. In reading, South Africa was tenth of the fifteen countries measured. In mathematics, South Africa ranked eighth out of the fifteen countries (Spaull, 2011a: 24). Educational quality in South Africa therefore leaves much to be desired.

Poor teacher quality and low levels of teacher effort are often cited as major drivers of South Africa's education crisis. The question then is why South African teachers are performing as poorly as they do. NEEDU's National Report of 2012 suggests that teachers are unable to ensure high quality education for students either because they *won't* or because they *can't* (NEEDU, 2013: 20). Where teachers and schools *won't* provide quality education, poor performance is the result of a lack of discipline amongst staff member and any remedial action should focus on changing behaviour. Where teachers *can't* provide quality education intervention should focus on improving and enhancing the knowledge base of teachers to equip them with the skills necessary for quality teaching and learning to take place in classrooms (NEEDU, 2013: 20).

This chapter focuses on the potential to change teacher behaviour in a way that enhances student performance.

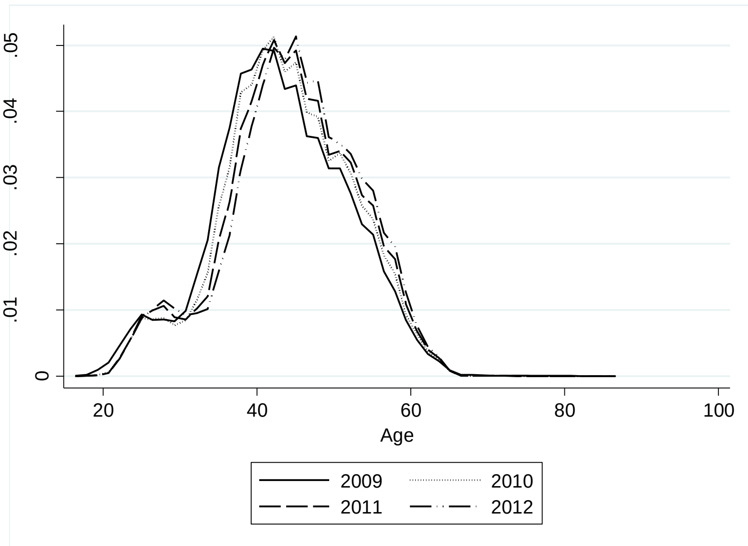
Many argue that the lack of effort amongst teachers is the greatest hindrance to the development of student skills in South Africa, suggesting that the appropriate policy response should be directed towards designing attractive incentives for teachers. High levels of absenteeism from school and from classrooms, poor lesson preparation and lack of interest in the progress of learners are key signs that teacher effort is critically low in South Africa, and it is often reported that such low levels of effort result from weak incentive systems.

This problem is not particular to South Africa. Low levels of teacher effort are observed internationally. Teacher motivation is often explained as being driven by factors other than financial incentives, for example a love of children, passion for their subject or a drive to interact with students. However, Bennell (2004: 16) points out that in economic conditions in which teachers and their families struggle to make ends meet, remuneration is likely to be a significant factor in motivating teachers and indeed in attracting individuals to the profession. Research in low income countries in Sub-Saharan Africa and South Asia indicate low levels of teacher motivation. The cause of low levels of motivation vary by country, but factors such as low morale, lack of job satisfaction, low levels of incentives, and inadequate behavioural sanctions feature across education systems (Bennell, 2004: 22). Furthermore, the expectations associated with teachers' work are unrealistic given the environment in which teachers are expected to teach and live, the monetary rewards associated with teaching and the workloads with which they contend (Bennell, 2004: 20). Importantly, the conditions in which teachers in low income countries are expected to teach have special demands for which teachers may not be sufficiently trained. A prominent example is widespread multi-grade teaching in Sub-Saharan countries – an exceptionally demanding skill. Most teachers are simply not prepared for the demands associated with such practices (Bennell, 2004: 21).

International research findings indicate that an important source of service delivery failure in education is the teacher. The principal-agent problem in education is complicated because of the nature of service provision in education (Bruns, Filmer & Patrinos, 2010: 10-11). The interaction between teachers and learners is discretionary (in that it is the teacher's own judgement that will determine what is taught and how it is taught), variable (in that teachers are required to tailor their teaching style to a diverse group of students) and requires repetition. It is exceptionally difficult to define beforehand what type of behaviour and actions teachers must take. It is challenging therefore to write a contract according to which they are expected to conduct themselves as well as to monitor their behaviour (Green, 2011: 16).

A further concern regarding the teaching force in South Africa and internationally is the rate of attrition. The non-pecuniary aspects of teaching (probability of employment, holidays, class sizes, status of the profession, to name a few) play a significant role in the decision to teach (South Africa Council of Educators (SACE), 2010: 4). It is important to understand what convinces teachers to leave the profession. The rate at which teachers leave the profession may be thought of as indicating the attractiveness of the teaching profession. Higher rates of teachers leaving the profession are intuitively associated with a less attractive profession. If highly able teachers are also the most likely to leave the profession, then high levels of teacher turnover have significant implications for teacher quality (Harris and Adams, 2007: 325). Important to consider when investigating teacher turnover is the proportion that can be attributed to retirement. In a country like South Africa, that has what can be considered an ageing teaching force, this may constitute a considerable proportion of teacher turnover. Indeed more than half of South African teachers (56%) were older than 40 in 2005 (Department of Education, 2005: 61). More recent numbers obtained from government payroll data show that the modal age for teachers in 2009, 2010, 2011 and 2012 is older than 40 years of age, and that this increases very slightly in each year. Age distributions for the years 2009 to 2012 are presented in figure 19 below.

FIGURE 19: Age distribution of teachers, 2009 – 2012



Source: Persal October Downloads, 2009–2012

Harris and Adams (2007: 336) point out the importance of understanding the role of retirement in teacher turnover. In the USA teachers tend to retire earlier than workers in non-teaching professions, so if teacher turnover is to be used as a measure of the appeal and "health" of the teaching profession, caution must be exercised.

Teacher turnover may also differ according to teacher specialisation. Murnane, Singer and Willet (1989: 32-33) find evidence in North Carolina that the median "lifetime" of secondary school teachers differs according to subject speciality, with chemistry and physics teachers as well as biology teachers having significantly shorter lifetimes within the schooling system than do their colleagues in English, social science and mathematics[17]. The authors explain that a possible explanation for this is the higher mean starting salaries for occupations in the field of physics, chemistry and biology (Murnane et al., 1989: 333). The authors have no persuasive explanation for the peculiar result that mathematics teachers have the longest median lifetime but suggest that this may be due a "mismatch" between the skills required amongst mathematics professionals in the business and industry and the skills acquired by mathematics teachers (Murnane et al., 1989: 334). They refer to computer skills as an example. Despite the fact that the results obtained are from a US context, there does appear to be evidence that the opportunity cost of teaching is higher for teachers of subjects that may be considered "scarce skills" in the sense that they are likely able to command higher remuneration in non-teaching professions.

Falch and Strøm (2005) attempt to quantify the impact of non-pecuniary factors on teacher attrition in Norway[18]. This study is possible in the Norwegian context given the fact that teacher wage setting is completely centralized and schools may not offer wages different to what has been stipulated by teacher unions (Falch & Strøm, 2005: 612). This eliminates identification problems that may arise as a result of compensating wage differentials which means it is possible to interpret teacher behaviour as a response to non-pecuniary factors. They find that high proportions of minority students (i.e. non-Norwegian students) and special needs students are associated with a higher quit rate amongst teachers (Falch & Strøm, 2005: 628) and school

[17] The observed lifetimes for chemistry and physics, biology, English, social studies and mathematics teachers are 5.9, 6.3, 6.5, 7.6 and 10.1 years respectively (Murnane et al., 1989: 333).
[18] Norway is admittedly a weak compactor country for South Africa. However, very few studies attempt to quantify the impact of non-pecuniary aspects in the form of school characteristics (i.e. student composition, school size) of teaching.

size is also positively and significantly associated with teachers quitting (Falch & Strøm, 2005: 627). These results pertain to movements between schools within the same district, movements between districts as well as departures from the education sector.

From an economic perspective, it may be difficult to measure the effect of non-pecuniary characteristics of teaching on teacher turnover in South Africa, as economics assumes that wages will adjust to reflect the non-pecuniary aspects of teaching. The Norwegian example is useful (and possible to measure) due to the fact that deviations from the national salary structure do not occur. This is not the case in the South African context. In South Africa, schools may offer teachers wages that differ from what has been stipulated centrally. Many schools employ and remunerate additional teachers or supplement the wages of teachers with privately raised funds. This differs somewhat from the Norwegian case.

Hall, Altman, Nkomo, Peltzer and Zuma (2005) conducted a study into the reasons for teacher attrition in South Africa. The study was conducted in order to "determine the impact of job satisfaction, morale, workload and HIV/AIDS on South African teachers who are thinking about leaving the profession" (Hall et al., 2005: 5). The study was conducted on a nationally representative sample of 24 200 teachers from 1 766 schools across South Africa. Table 4 below presents the reasons given for wanting to leave the teaching profession by those who indicated they considered doing so and the proportion of this group who stated the respective reasons.

TABLE 4: Reasons for wanting to leave the teaching profession

FACTOR	PERCENTAGE
Teaching outside South Africa	4.1
Teaching at a private institution	3.9
Change to another career	24.6
Go back to university/college to study something different	4.4
Better salary	52.3
Other	9.2
Unknown	1.5

Source: Hall et al., 2005

Apart from higher remuneration, the most widely stated reason for wanting to leave the teaching profession was to pursue an alternative career path. A large proportion of teachers (more than three quarters of those wanting to leave the profession) cited lack of career development opportunities in teaching (Hall et al., 2005: 8). These proportions also varied according to the level of education attained by teachers, with better educated teachers more likely to state the lack of career development opportunities as reason to leave (Hall et al., 2005: 9).

A further drain on South Africa's teacher supply is South African teachers opting to work abroad in other education systems. The poor image of the profession is often mentioned as one of the factors explaining teachers' opting to work in other education systems (Centre for Development Enterprise (CDE), 2011: 12). Estimates of South African teachers leaving the country between July 1997 and July 2006 are at 10 000 South African teachers migrated to the United Kingdom alone (CDE, 2011: 12).

It appears then that teaching in South Africa is not appealing from a professional point of view. Furthermore, the conditions in which a large number of teachers are expected to work are undesirable. So what can be done to attract highly able individuals to the profession? Aside from increasing teacher wages, how is it possible to convince people best able to affect student outcomes to the teaching profession? What type of incentives exist? Incentives can be thought of as being comprised of two different types: incentives that are inherent to the teaching profession and those that are explicitly imposed on the profession. From a labour market perspective, incentives inherent to the teaching profession are those that exist in the wage structure faced by teachers discussed in chapter 1. Explicit incentives include incentive schemes rewarding good performance. To the extent that incentives may render the teaching profession more financially attractive as well as present opportunities for professional development, they may discourage teachers who would otherwise leave the profession to stay.

Many advocate the implementation of incentives for teachers as a possible channel through which to enhance student ability and skills development. An important motivation for implementing incentives for teachers is that they explicitly state the results that are valued by the education authority and therefore of teachers, thereby enhancing their accountability. The agreement between authorities and schools is enhanced because expectations with regard to service provision are explicitly specified. Bruns et al. (2010: 19-20) discuss pay-for-performance as a possible avenue to provide incentives to teachers and ensure accountability. Pay-for-performance largely leaves the teacher salary scale untouched while creating incentives at the margin. Unlike salaries, this kind of incentive pay rewards teachers for what they actually do or achieve during a specified period, rather than for what their qualifications and training suggest they are capable of doing. The correlation between the observable characteristics of teachers and the level of achievement attained by their students is weak (Bruns et al., 2010: 20).

Examples exist of incentive schemes which have succeeded in improving student performance. Ballou (2001) investigates the implementation of incentive schemes in private and public schools in the USA. Ballou finds that private schools employ incentive schemes for teachers more often than do public schools. Ballou (2001: 57) explains that different "market sanctions" are at play in the private school sector surrounding performance. Private schools' survival depends on their ability to "retain the kinds of teachers that sustain the school's reputation" (Ballou, 2001: 57). Schools place themselves at a significant disadvantage if they are unable to retain a staff of teachers considered by parents to be "cream of the crop". Attracting highly able teachers through implementing incentive systems therefore renders a school attractive to prospective clients and ensures that enrolment is high. This aspect of incentives systems in private schools suggests that incentives may be experienced as beneficial for all teachers within a particular private school, resulting in private school teachers being more inclined to support the implementation of incentive schemes (Ballou, 2001: 57). In other words, in private school settings the prestige of the school is to some extent dependent on the perceived quality of the teachers. It seems then that when teacher quality is important, administrators make use of incentives. Ballou (2001: 60) concludes that it is not the nature of teaching that renders teacher incentives ineffective, but rather the conditions and incentives of the public school sector.

Figlio and Kenny (2007: 903) also find a positive influence of teacher incentives on student learning. They offer two possible interpretations for this result. The first is understanding that teacher incentives could result in higher levels of effort amongst teachers, which translates into improvement in student performance. The second is that schools that implement teacher incentives are most effective in unobservable ways, suggesting spurious results for teacher incentives (Figlio & Kenny, 2007: 903).

Podgursky and Springer (2010) conducted a review on teacher performance pay in the US education system from kindergarten to senior secondary school and find an overall positive relationship between the use of teacher incentives and student performance, but they explain that there is less clarity surrounding the exact form that incentives schemes take.

This paper examines the theoretical characteristics of incentive systems, detailing the potential for distortion as well as the conditions under which peer pressure is effective as an accountability- and performance-enhancing force. Section 2 provides a brief overview of incentives in economic theory and specifically in education. Section 3 presents theoretical models of incentive systems and investigates the characteristics of such systems while section 4 draws up a brief framework from the theoretical models presented in section 3 according to which international incentive systems are evaluated in section 5. Section 6 analyses the potential for the introduction of incentive systems in South Africa and explores incentives inherent to the South African teaching profession.

2. Economic theory and incentives

This section serves as an introduction to thinking about incentives in an economic context with specific reference to education. The objective is to sketch the broad framework in which the theoretical models of section 4 are situated.

Research on the use of incentives in organizations generally makes use of an economic framework which analyses the difference in the objectives of different individuals who make up an economic organization. Specifically, the objective of the organization as a whole (which is characterized by the objective of the owner or "principal" of the organization) is contrasted with the objectives of workers within the organization, i.e. the objectives of the "agent". Differences in these objectives imply that workers will not necessarily behave in a way that maximizes the objective of the organization as a whole or with the principal's objectives for the organization, therefore rendering it less productive and worsening the situation for workers in the long run by diminishing either productivity or employment. Incentives may therefore be used to encourage workers to work towards the objectives of the organization as a whole.

A classic example of such incentives is what is referred to as a “piece rate” – a rate paid to workers based on their level of productivity or the number of “pieces” they produce as opposed to a salary based on the number of hours workers work. Increased profits will result from workers producing more per hour, so incentivizing this production directly may have a greater positive impact on productivity than would be the case if workers were paid by the hour (Hout and Elliott, 2011: 21).

The efficiency of incentives is, however, very much dependent on the social relations that evolve around “piece work”. Complexities beyond simply paying for productivity instead of paying hourly arise when dealing with incentives, and these require some understanding of how incentives work in different contexts and for different people. Five complexities requiring attention are:

1. Finding performance measures
2. Different incentive effects on different people
3. Uncertainty and control
4. Effects of working in groups
5. Weighing the costs and benefits of incentives.

These complexities are each considered below.

2.1 Finding performance measures to use with incentives

In most jobs, output cannot be counted in any meaningful way, making it difficult to measure the contribution of each worker. Often the qualitative aspects of the job performed are more important than the aspects that can be quantified. The difficulties inherent in quantifying incentives are a major constraint to providing them, and the gap between the measures available for the measurement of incentives and the actual value of the output has important implications for the operation of incentives. “Objective” measures of performance obviously focus on the quantifiable aspect of the job at the expense of qualitative aspects, given the difficulty in measuring these. It is not surprising then that when incentives are attached to the quantifiable performance measures, workers focus on these aspects of the job and neglect those that do not affect the performance measure. This is problematic when performance measures are not closely aligned with the true value of the work being done. The performance measures are said to be "distorted" when they result in behaviour that is detrimental to the true value of the organization or simply fail to enhance the value to the firm (Hout & Elliott, 2011: 22-23).

Defining the underlying goals that performance measures should reflect can be highly problematic. In the case of education, schools are required to ensure that students meet some minimal standard of academic performance, but are also held responsible for developing cognitive skills, ensuring physical and emotional development, preparing students to enter the workplace and society and for students' health and safety. Whilst these goals are not inconsistent they compete for limited resources, forcing schools to make difficult trade-offs. Ideally each goal would have one performance measure, but this is simply not practical to implement and so further trade-offs in the selection of performance criteria are needed (Dixit, 2002: 712). Once performance measures have been selected, further decisions need to be made regarding how each performance measure will be weighted in the overall incentive scheme. Agreeing on a performance measure to be implemented is therefore a considerable challenge.

A theoretical analysis (Baker, 2002 – discussed below) shows that more important than correlation between the performance measure and the value of the organization is whether behaviour that improves the performance measure also enhances genuine value; in the case of education, this would be genuine learning amongst students. This distinction is important because a performance measure may be correlated with a wide range of outcomes-absent incentives (i.e. high levels of the performance measure is correlated with high overall performance). However, once incentives are attached to the performance measure, behaviour that increases the performance measure at the margin may not enhance overall performance at all. This is known as "gaming" the system (Koretz, 2008: 24).

In the field of education, the strength of incentives currently in place is not straightforward. Studies of cheating by teachers show that even when incentives are small, some teachers react quite strongly in a distorting way while others genuinely increase their level of effort (Hout & Elliot, 2011: 26). As mentioned before and as will be discussed below, the behavioural impact of a given incentive or set of incentives will cause different people to behave in different ways and will depend largely on the context in which individuals work.

Incentives systems therefore inevitably have some level of distortion in them and so the objective of evaluating incentive systems is not to ascertain whether incentives exist, but rather whether the costs involved in minimizing the distortion are outweighed by the benefits of implementing the incentive system.

A possible alternative to using student test scores to evaluate teachers is requiring school principals to rank teachers according to their perceived performance. Some may again question the fairness of this measure given its subjectivity. However, Jacob and Walsh (2011: 447) find evidence that principals' rating of teachers correlates strongly with teacher characteristics that are strong predictors of student performance. For example, they find positive associations between ratings and experience for the initial years of teaching, but no association for 10 years of teaching experience and higher. They find a negative association between teacher absence and ratings and positive correlations between characteristics of teachers' educational background[19] and ratings (Jacob & Walsh, 2011: 435)[20]. The authors admit that their analysis does not provide a direct link between ratings and student performance, but given the relationship between teacher ratings and correlates of teacher productivity, there is reason to be optimistic about the ability of principals to recognise teacher quality.

2.2 Different effects of incentives on different people

Economic theory postulates that different people are likely to respond differently to incentive structures. Amongst people for whom the target is easily attainable, incentives are likely to result in greater levels of effort relative to those for whom the target is difficult to achieve (Lazear, 2003: 186). This means that people who are able to reach the target are likely to be attracted to and remain at the organization while those who are likely to be unsuccessful will become discouraged and leave. This may enhance productivity since low-productivity workers will leave the organization and be replaced by more productive workers. An application of this to the area of teaching by Lazear (2003) applies a model in which teachers have different abilities to raise student test scores and produces the result that some teachers increase their effort while others leave the teaching profession. The fact that the teachers that left the profession are the teachers who are less able to raise test scores would be an enhancement in the overall effectiveness of teaching over time.

A variation of this model is one in which teachers respond to incentives by either increasing effort or by increasing effort in test preparation (assuming test scores are the performance measures upon which the incentives are based). The performance for teachers engaging in both

[19] Whether teachers majored in education, maths, English or social sciences (Jacob and Walsh, 2011: 440).
[20] Jacob and Walsh (2011: 447) point out that the association between principals' ratings of teachers and attributes linked to higher student proficiency is stronger at the upper and lower end of the "ability distribution". Principals seem less able to identify teacher quality in the middle section of the ability distribution.

forms of behaviour will increase student test scores, but actual learning will only take place amongst students taught by teachers in the first group. This type of distortion is discussed in detail in section 3.3.

2.3 Effects of uncertainty and control in providing incentives

In almost all jobs, a worker's actual performance and the performance measure may be affected by factors outside of the worker's control. In the case of pay-for-performance incentives, it is likely that payoffs received by workers as part of the incentive scheme will depend both on the workers' effort and factors beyond their control. As a result, in situations where their pay is going to be affected by factors beyond their control, they will require compensation for this uncertainty in the form of higher levels of pay (Hout & Elliott, 2011: 27).

Theoretical analysis shows that optimal incentive schemes will allocate less weight to measures that are more dependent on factors beyond the worker's control (Baker, 2002: 3) since these incentive schemes require greater average pay levels in order to compensate workers for the greater level of uncertainty in their pay relative to what they might have received in another job (without incentives). Ultimately then, although productivity is enhanced by the use of incentives, the higher level of average pay that workers require is costly (Baker, 2002: 4-5).

There are numerous factors beyond the control of schools and teachers that impact on student learning. In particular, characteristics of students' home environments result in substantial variation in the performances of students and a student's performance over time – one of the primary reason for the strong opposition to incentives based on student performance amongst teachers.

2.4 Effects of groups in providing incentives

Trade-offs in performance available performance measures are inevitable in environments where the value of work done depends on cooperation amongst workers. Performance measures that consider only individual worker production will neglect the contribution made by individual workers to the productivity of the entire team, while measures of the productivity of the team will provide a vague and possibly inaccurate indication of an individual worker's performance because they are determined by the contributions of the entire team. Whether team-level or individual-level measures of performance should be incentivized is dependent on the relative importance of cooperation and on the uncertainty inherent in such performance measures (Hout & Elliot, 2011: 30).

Education is a prime example of a field requiring cooperation amongst workers. Research in fields other than economics points out the importance of understanding how schools function as organizations i.e. understanding the extent of cooperation required amongst teachers. For example, sociological research looks at understanding incentives in a setting where consequences are not explicitly defined, investigating how incentives are communicated in an informal way between workers (Meyer & Rowan in Hout & Elliott, 2011: 30. The combination of economic and other research indicates the importance of considering the impact of incentives beyond those directly relevant to the individuals within an organization. Furthermore, the degree to which work in done jointly and the degree to which the direct effect of incentives will be transmitted to other members of the organization must be considered (Hout & Elliott, 2011: 31).

An organizational structure as complicated as a school requires one to consider the different roles and interactions between individuals working at the school. There may well be value in incentivizing individuals relatively high up in the hierarchy who have the capability to transmit the incentives in ways that result in cooperative behaviour (or at least encourage such behaviour). It is important to note that the extent to which the diffusion of incentives is imperfect requires that the behaviour which one is trying to adjust, as well as the ability of members in different roles within the organization to adjust the behaviour, should be considered carefully.

2.5 Weighing the costs and benefits of incentives

Ballou (2001: 51) examines teacher incentives in different settings (i.e. in the context of public and private schools) and provides a useful summary of some of the complications involved in implementing incentive schemes. He explains that the majority of literature on teacher incentives reports that they do not translate into long term improvements in student performance for a number of reasons. The first of these is that it is difficult to observe teachers' output, largely because educational output is the product of cooperative behaviour and so the isolated contribution of any individual teacher is difficult to measure. Secondly, the relationship between teaching and learning is quite obscure and it is often difficult for those tasked with administering incentives to explain why one teacher qualifies for the incentive and others do not. It is therefore difficult to stipulate criteria for awarding incentives and teachers often become frustrated and disillusioned with the process. Thirdly, education output is difficult to measure. Awarding incentives based on observable measures of output may result in distortive "gaming" behaviour. Finally, incentives may create a culture of competition amongst teachers, resulting in non-cooperative and opportunistic behaviour – a situation that is likely to affect education outcomes negatively (Ballou, 2001: 51). It seems therefore that the ineffectiveness of teacher incentives is largely due to the nature of the process of education (i.e. how teaching is translated into learning) and the nature of the teaching profession. If the process of education was in fact what rendered incentives ineffective, then incentive systems would be used (or avoided) to the same extent in both private and public schools. However, if these systems are employed to differing extents across the public and private schooling systems, then it important to understand how differences between the two sectors affect the effectiveness of incentives (Ballou, 2001: 52).

The fact that distortion occurs with performance incentives does not mean that they should not be used at all. Distortion will mean that it is more difficult to measure the benefits associated with incentives and that some parts of the organization may function less efficiently than they might have in the absence of incentives. It may, however, still be true that the benefits resulting from the implementation of incentives are greater than the costs. Improvement in cognitive skills is associated with improvements in income distribution, individual earnings and economic growth (Hanushek & Woessman, 2008) and an incentive system that produces true learning gains may well produce a sizeable net benefit. However, unless one accounts for the level of distortion in such test-based incentives the size of the benefit is likely to be grossly exaggerated.

Incentives can therefore prove useful in the context of education, despite the problems inherent in their implementation. Section 3 provides a theoretical analysis of incentives in the teaching profession.

3. Theoretical models of teacher incentives

Section 2 placed incentives in the context of economic theory and discussed some of the complexities involved in making use of incentives. This section looks at particular models of incentives in the context of teaching.

3.1 Incentives based on input and output

The payment of incentives on the basis of inputs or outputs is a central question in the literature on teacher incentives. The risk inherent in rewarding workers on the basis of what they produce means that output-based incentives are not always fair. As discussed above, this characteristic of output-based pay is particularly relevant in education. In some cases therefore, it may be necessary and preferable to reward workers on the basis of input. Lazear (2003) explains input- and output-based pay.

3.1.1 Output-based pay

The most important objective in an education system is the education of the population so as to ensure productivity, allowing individuals to generate skills and thereby an earning to sustain themselves and in turn generate economic growth. It may therefore be said that generating and developing earning capacity is the central objective of education (Lazear, 2003: 183).

Earnings, however, are only observed some time after individuals have left the schooling system, rendering it impossible to determine teacher pay on this basis. As a result, student achievement test scores are usually used as proxies.

When test scores are used as the basis for teacher pay, it is difficult to distinguish the increases in test scores resulting from teacher efforts and those resulting from the activities of others. Furthermore, improved test scores may result from distortive behaviour on the part of teachers as opposed to genuinely enhanced effort levels.

3.1.2 Input-based pay

The advantage of paying workers based on input is that it removes the risk inherent in output-based pay, therefore discouraging teachers from focussing exclusively on the performance metric according to which they are paid.

Input-based pay may be seen as a solution to the problem of "teaching to the test", or distortion in the context of the incentives literature (Baker, 2000; Holmstrom & Milgrom, 1991). In the extreme case, a perfect measure of the disutility of working[21] would be used as the measure according to which workers were paid. In this case, there would be no incentive to focus on one area of the curriculum at the expense of others. Teachers would receive full compensation for their efforts and would likely be willing to do what is in the best interest of their students, regardless of the level of effort required. Using disutility as the basis for compensation would ensure that teachers remained indifferent to which areas of the curriculum they emphasise and hopefully induce them to make sure that all areas are covered. This results from the fact that providing payment on the basis of disutility ensures that they receive enough to compensate them for teaching the "disagreeable" subjects.

Input-based pay works well insofar as hours worked are a proxy for the disutility of teaching. However, when teachers care about what activities they engage in while teaching, input-based pay will no longer be effective at eliciting sufficient effort from teachers. The non-teaching labour market deals with this problem to some extent by compensating different occupations differently. Lazear (2003: 195) explains that "[institutions are prevented from] hiring professors of accounting at the same wage that can attract professors of organisational behaviour" due to the fact that "[the wage] difference is compensation for perhaps less pleasant or more difficult work".

3.1.3 What works better?

The literature on teacher incentives favours output-based pay for two reasons. The first advantage (the "informational" part) is that output-based incentives clearly signal to teachers what is valued and required. The second advantage (the "alignment" part) ensures that the

[21] It is assumed that different aspects of teaching or teaching different parts of the curriculum have different disutilities.

objectives of teachers closely parallel those of society as a whole. It may well be the case that teachers work hard, but that there is disagreement about which areas of the curriculum are important. By tying teacher compensation to an agreed-upon metric, it is possible to ensure that the education provided by teachers results in the accumulation of agreed-upon skills amongst learners (Lazear, 2003: 209). Finally, there may be some divergence between the preferences of teachers and the best interests of their students. Lazear (2003: 182-183) gives the example of teachers deciding against giving assignments because of burden of grading, even though they are fully aware that their students would benefit from completing the assignments. Therefore compensation based on students' performance on the assignment may induce teachers to behave in a way that is beneficial to their students.

If incentivising teacher performance is thought to be effective in enhancing the quality of education, then it is important to understand the mechanism through which the improvement is likely to occur. Section 3.2 explains two possible avenues of influence through which teacher incentives are likely to impact on student performance – an "incentive effect" and a "sorting effect".

3.2 Sorting versus incentive effects and the likelihood of success

The "selection" aspect of compensation is arguably the most important aspect in the context of education. The individuals attracted by various compensation schemes determine the quality of individuals within a profession. It is widely accepted that teacher quality is critical to quality education and so the question of who is likely to enter the profession is crucial.

When teachers are faced with an incentive based on student performance, they must improve student performance in order to be rewarded. Sorting refers to using incentives in order to attract individuals who are better able to improve test scores to the teaching profession, resulting in a teaching force that is better able to improve student performance. Payment based on output therefore attracts individuals who are best able to enhance student performance and may discourage weak teachers from continuing in the profession given the relatively lower levels of pay they will receive as a result of their inability to improve student performance. Sorting therefore results in better teachers replacing less able teachers. This differs from the effect of incentives, as in the case of incentives the individual is not replaced but adjusts his or her behaviour (Lazear, 2003: 187).

Teachers able to raise student performance therefore do better on a performance-based schedule while those unable to do so will do better on a fixed wage schedule. Pay based on student performance therefore favours teachers who are able to increase student performance relative to those who are unable to do so.

Is teacher quality and teacher productivity therefore driven primarily by teachers' innate ability or does the level of effort put into teaching influence the level of teacher productivity? Neal (2011) discusses the importance of distinguishing whether teacher quality is dependent on teacher effort, teacher ability or a combination of both. He maintains that it is only if teacher quality is a function (at least in part) of teacher effort that incentives are likely to influence student performance. Ignoring teacher effort as a contributing factor in educational quality counters much of the empirical literature on the subject of teacher productivity; if poor teachers are teachers who are unable to master the skill of teaching well, then incentive provision is unlikely to improve student performance in any significant way. However, if poor teachers are unmotivated and "lazy" teachers, then the introduction of well-designed incentives may well contribute to improved student performance. The extent to which teacher productivity is driven by effort determines to some degree the likelihood of success in the implementation of incentives (Neal, 2011: 8).

It is undeniable that teachers vary substantially in their levels of productivity, in South Africa and internationally. The fact that differences in productivity exist says nothing about whether teachers provide efficient effort given their level of talent. Teachers may well operate according to different "effort norms". It is therefore necessary to ascertain whether or not productivity is likely to change if effort is incentivized, and this means ascertaining whether or not productivity depends on teacher effort.

3.3 Moral hazard and the risk of distortion

"I come to the following pessimistic laws. . .: The more any quantitative social indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor" (Campbell, 1976). This section discusses the risk involved in incentivising teacher performance. It discusses the risk of encouraging sub-optimal behaviour and how this comes about with the introduction of incentive schemes.

3.3.1 Multitasking and the risk of distortion

A criticism often levelled at performance-based incentives is that if incentives are used in order to encourage teachers to provide higher quality education to their students, teachers may improve test scores (according to which payments are made) without actually enhancing learning – behaviour known as distortion. Distortion may also occur when the sorting effect is at play. If we believe that education is valuable to individuals because of its impact on future earnings and we are using student test performance as a measure of learning, it may well happen that teachers who are able to increase student test scores without influencing their learning are drawn into the profession (Lazear, 2003: 187).

Neal (2011: 10) uses a special case of the multi-tasking model of Holstrom and Milgrom (1991), a model often used to explain the behaviour of teachers in various merit pay schemes.

Assume that in an education system teachers allocate their effort between two tasks. The amount of time the teacher allocates to task 1 and task 2, respectively, is denoted by t_1 and t_2. The human capital production function is given by

$$h = f_1 t_1 + f_2 t_2 + e \qquad \textbf{(1)}$$

where human capital acquired by the student as a result of teacher effort is $(h - e)$ (Neal, 2011: 10). h denotes additional student skill and it is measured in dollars. f_1 and f_2 are constants and e is a random error term that captures factors affecting a student's rate of learning beyond the teacher's control. h, t_1 and t_2 are not observable by the authority, but the authority is able to observe a statistical measure of teacher performance p,

$$p = g_1 t_1 + g_2 t_2 + v \qquad \textbf{(2)}$$

where g_1 and g_2 are constants and v is a random error influencing measured performance (Neal, 2011: 10-11). v and e are shocks and are independently drawn with mean zero. They are also assumed to be independent of t_1 and t_2. The teacher's utility function is

$$U = X - C(t_1, t_2) \qquad \textbf{(3)}$$

where the teacher's expected income is given by X and the cost associated with any pair (t_1, t_2) is given by $C(t_1, t_2)$. An optimal compensation contract is designed by the education authority, given by

$$w = s + bp \tag{4}$$

in which s is the base salary and the bonus measure b is paid according to the measure of performance p (Neal, 2011: 11). Given b, a salary s can be chosen to result in a given level of teacher effort based on some utility option U_0.

The optimal bonus rate solves

$$\max_{b} f_1 t_1(b) + f_2 t_2(b) - C(t_1(b), t_2(b)) \tag{5}$$

subject to

$$[t_1(b), t_2(b)] = \arg\max_{t_1, t_2} \quad s + b(g_1 t_1 + g_2 t_2) - C(t_1, t_2)$$

The optimal bonus rate therefore maximizes the difference between the human capital that results from the teacher's actions and the cost to the teacher of those actions (Neal, 2011: 11). Teachers will respond to any bonus rate b by choosing actions that maximize utility given b. The cost function for teacher effort is given by

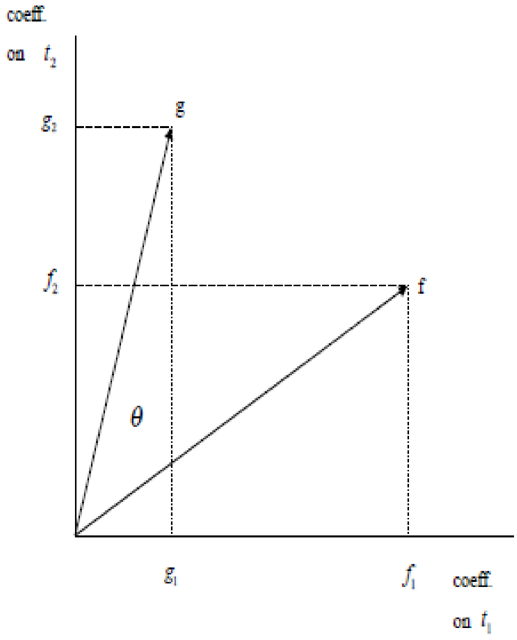
$$C(t_1, t_2) = 0.5(t_1 - \bar{t}_1)^2 + 0.5(t_2)^2 \tag{6}$$

where $\bar{t}_1$ is a norm for the amount of effective instruction. This is considered fixed and not affected by the incentive system and so is taken as given in the calculation of the optimal incentive structure. Importantly, it is stipulated by the education authority and is therefore assumed to be observable by them. This assumption is relaxed shortly. From the cost function is can be shown that the optimal bonus rate is

$$b^* = \frac{f_1 g_1 + f_2 g_2}{g_1^2 + g_2^2} = \frac{\|f\|}{\|g\|} \cos\theta \tag{7}$$

with θ the angle between vectors (f_1, f_2) and (g_1, g_2) (Neal, 2011: 12).

FIGURE 20: Angle between vectors (f1, f2) and (g1, g2)



The formula for b indicates that the alignment factor θ is important for the optimal bonus rate. If the vectors are orthogonal, such that ($f_1 = 0$, $f_2 > 0$) and ($g_1 > 0$, $g_2 = 0$), then $\cos\theta = \cos 90 = 0$ and $b^* = 0$. In the case of perfect alignment $\cos\theta = \cos 0 = 1$.

3.3.2 The efficiency of incentive pay in education

Neal (2011: 13) discusses whether the presence of at least some incentive pay is optimal in this model, i.e. whether $b^* > 0$ is optimal. The version of the model presented above indicates that incentive pay is optimal as long as $f_1g_1 + f_2g_2 \neq 0$. In cases where $b^* < 0$, it is possible for the authority to institute $b^* > 0$ by simply specifying a new performance measure $p' = -p$.

As long as all of the constants (f_1, f_2, g_1, g_2) are non-negative and at least three are strictly positive, then the condition that $f_1g_1 + f_2g_2 > 0$ will hold. In other words, as long as

i) one of the teacher's activities contributes to output as well as the performance measure,
ii) the other task contributes to output or the performance measure or both, and
iii) neither task is detrimental to either the performance measure or real output,

then $b^* > 0$ is optimal (Neal, 2011: 13). If t_1 are activities that generate genuine increases in human capital, and t_2 are activities that may be considered "gaming the system", such as teaching to the test or changing the answers of students before the assessment is graded, then it is widely assumed that the impact productive behaviour on genuine human capital accumulation amongst students is positive ($f_1 > 0$), that this behaviour improves the performance measure ($g_1 > 0$), that gaming behaviour improves the performance measure ($g_2 > 0$), and as long as gaming activities do not diminish human capital amongst students, then their impact will not diminish human capital amongst students ($f_2 \geq 0$). Optimal policy should always then include $b^* > 0$. The separability of the cost function is an important assumption for this framework. $b*$ is only optimal to the extent that teachers can consciously and willingly decide on the combination of t_1 and t_2, implying that they are able to distinguish between which of their actions genuinely enhance the skills of students and which of them simply enhance their performance measure. Without this assumption, the optimal policy of $b^* > 0$ is not a robust feature of the multi-tasking model (Neal, 2011: 13).

Given that education requires the time of both students and teachers, and given the restricted nature of students' attention and energy, it may be worth considering cost functions that take the form

$$C(t_1, t_2) = 0.5(t_1 + t_2 - \bar{t})^2 \qquad \textbf{(8)}$$

In this cost function, t_1 and t_2 are perfectly interchangeable and $\bar{t}$ is a total effort norm that impacts on teacher costs. It is assumed that teachers choose $t_1 = \bar{t}$ and that $t_2 = 0$ when no incentives exist. Given this setting, if the education system chooses $b > 0$, then teachers will choose $t_1 = 0$ as long as $g_2 > g_1$ and as long as there are many combinations of $\bar{t}$, f_1, f_2 and g_2 that would result in $b = 0$. So when $f_1 > f_2$ and $f_1\bar{t}$ are baseline outputs, an incentive scheme that results in teachers substituting a small amount of t_2 for t_1 will lower human capital gains to students without affecting teacher remuneration costs (Neal, 2011: 13-14).

However, if $\bar{t}$ is low enough, the result may still be an increased total surplus. Since t_1 can never be negative, the diminished output associated with the loss of $t_1 = \bar{t}$ may be compensated for by the benefits associated with increasing t_2 far beyond $\bar{t}$. Therefore, whether or not an optimal bonus rate (b^*) exists depends on what type of instruction happens in the classroom (effective teaching or "gaming" behaviour) and on the norm $\bar{t}$ within the education system (Neal, 2011: 14).

The nature of teacher activities denoted by t_2 that result from the introduction of incentive schemes is important to consider, as well as the relative values of f_2 and g_2 given the assumption that $g_2 > g_1$. Equally important, however, is considering whether increased t_2 activities result in increased teacher effort or whether it is simply substitution away from effective teacher behaviour t_1. If teacher effort is directed away from effective teaching practices towards gaming behaviour, the effect this will have on learning depends on the level of productive effort initially. In education systems where very little effort was directed towards effective teaching practices, an increase in gaming practices will increase the overall performance of the system because of the overall increase in teacher effort. In education systems in which the level of effort devoted to t_1 is high, incentives systems which result in less effective teaching practices and more gaming practices will result in a decline in the overall output of the system (Neal, 2011: 14). For example, it may be argued that in a system where teacher effort is extremely low, a change from no teaching to "teaching to the test" still represents an increase in the amount of teaching and learning compared to what was happening before, albeit only in areas which are likely to be tested and therefore impact on the performance measure. Therefore the overall output of the education system has increased. However, in the case where effective teaching and learning are taking place and students' skill bases are being expanded in all areas and not just those related to material likely to be tested, a movement towards "teaching to the test" and away from genuine skills-enhancing teaching will diminish the output of the education system. Furthermore, although it is possible to say that enhancing t_2 in systems characterised by extremely low levels of $\bar{t}$ may still enhance overall output of the education system, the long-term implications of encouraging such behaviour are significant and the development of a hard-working teaching force which contributes in a meaningful way to students' skills development becomes less likely.

The question is therefore whether incentive systems lead to improvements in student performance that result from increases in student skills, or whether the improvement in performance is the result of gaming behaviour which improves the measure of student performance without enhancing students' skills to the same extent that quality skills-enhancing teaching would.

3.3.3 Contamination and hidden actions

Coaching is not an optimal allocation of teacher effort, but some positive skills enhancement may result from certain forms of coaching. Indeed if coaching reflects a reduction in leisure time on the part of teachers rather than a reduction in effective teaching time, then teacher performance under an incentive scheme may well be enhanced relative to what it would have been under an accountability programme alone. However, teachers respond in ways other than coaching that constitute what Koretz (2008) refers to as cheating and which are unequivocally wasteful from the perspective of public welfare.

Jacob and Levitt (2003) give evidence of behaviour of Chicago teachers that clearly constitutes cheating: the teachers altered the answers of the students on high-stakes[22] assessments. This type of cheating is usually quite easy to detect because the performance of students being taught by cheating teachers is significantly out of line with their performance in other areas. In addition, the performance of these students reflected significant increases from the previous year, but only small increases (if any at all) in the year following the cheating.

Figlio and Winicki (2005) present evidence from Virginia that on the day that an assessment took place, the sugar content of the meals given to students was increased. It appears that school officials were responding to literature on the positive correlation between academic performance and glucose intake. This is a prime example of agents' behaviour which enhances their performance measure but does not actually have a real impact on skills enhancement.

The multi-tasking model underlines the possibility that inefficient teaching behaviour may result from the implementation of incentive schemes. However, it also draws attention to the fact that in situations where the level of teacher effort is very low, even teaching practices that enhance only the performance measure may result in an overall increase in teacher effort, leading to an overall increase in welfare within the education system. In terms of the long term objectives of education (the improvement of students' skills), it is clear that teaching behaviour that enhances the performance measure without actually altering the level of human capital generated amongst learners is undesirable. This emphasizes a problem with using measures of student performance as the basis upon which incentives are paid. The fact that it is susceptible to "gaming" highlights the difficulties faced by the education authority with regards to monitoring teacher responses to incentive programmes. A possible remedy to the issue of monitoring is the use of partnerships and peer pressure amongst teachers to elicit appropriate teaching behaviour in the presence of an incentive programme. Subsection 3.4 analyses the

[22] "High-stakes" refers to the fact that either incentives are awarded or sanctions are imposed on the basis of the outcome of the assessments.

channels through which peer pressure and partnerships are likely to influence behaviour under incentive schemes.

3.4 Peer pressure and partnerships

The creation of partnerships and profit-sharing arrangements stems from the need for internal motivation which arises mainly because of the prohibitive cost of monitoring employees, as well as the problem of the the accuracy of observable performance measures. By rewarding and punishing workers as a team, sufficient incentive may be provided for workers to supply an adequate level of effort. The idea is that team members are in a better position to control and discipline one another while simultaneously having a real incentive to do so, given that the overall payoff and therefore their individual payoff is contingent on producing a level of output that is only attainable with a certain amount of effort from each individual worker (Kandel & Lazear, 1992: 802).

This subsection explores the conditions under which peer pressure operates.

3.4.1 Free-rider effects and peer pressure

Suppose that a group of identical workers produces output $f(\boldsymbol{e})$, so that output is a function of the individual effort of each worker e_i. Therefore $\boldsymbol{e}$ is an N-dimensional vector of the levels of workers' effort with N workers. $f(\boldsymbol{e})$ is assumed to be non-separable in e_i ensuring a reason for partnerships. This would be tantamount to saying that pupil education depends on the effort of all of their teachers and that overall effort is non-separable (Kandel & Lazear, 1992: 803).

The cost of effort is denoted $C(e_i)$ with $C` > 0$ and $C`` > 0$. The worker seeks to maximize

$$\max_{e_i} \frac{f(\boldsymbol{e})}{N} - C(e_i) \qquad \textbf{(9)}$$

with first-order conditions

$$\frac{f_i(\boldsymbol{e})}{N} - C'(e_i) = 0. \qquad \textbf{(10)}$$

Efficient production requires the maximization of total surplus

$$\max_{e_1, e_2, \dots, e_N} f(\boldsymbol{e}) - \sum_{i=1}^{N} C(e_i) \qquad \textbf{(11)}$$

with first-order conditions

$$f_i(\boldsymbol{e}) - C'(e_i) = 0 \quad \forall\, i. \tag{12}$$

Given that $C`` > 0$, $\boldsymbol{e}*$, the solution to (12), is therefore larger than $\boldsymbol{e}`$, the solution to (10), for all N > 1. The level of effort chosen in a partnership is below the efficient level (Kandel & Lazear, 1992: 804).

When effort is observable, the best solution would be to pay workers $a + b\mathbf{e}$ where $b = f_i(\mathbf{e}*)$. However, the root of the problem is the observability of effort. Payment on the basis of effort is therefore ruled out and we investigate the effect of peer pressure on effort.

The "peer pressure" function is written as

$$peer\ pressure \;=\; P(e_i;\ e_j, \ldots, e_N, a_i, \ldots, a_N) \tag{13}$$

The pressure felt by worker i is dependent on his or her own efforts (e_i), the effort of peers (e_j, . . . ,e_N) and other actions taken by peers (a_i, a_j, . . . , a_N). The actions of workers[23] have no effect on output, but they do involve some cost to the workers. Cost is therefore redefined as $C(e_i, a_i)$. The general maximization problem for worker i then becomes

$$\max_{e_i, a_i} \frac{f(\boldsymbol{e})}{N} - C(e_i, a_i) - P(e_i; e_j, \ldots, e_N, a_i, \ldots, a_N) \tag{14}$$

Peer pressure differs from the cost of effort in the sense that it is social and dependent on the effort and actions of others, so it is to some extent external to the worker. That is, $P(\cdot)$ is subject to manipulation by the group in which the worker works. C(e) is not. We may therefore think about C(e) as the exogenous part of the utility of effort (in the sense that it is determined independently of the effect that peer pressure may have on utility) and $P(\cdot)$ as the part that is endogenous and cultural (Kandel & Lazear, 1992: 804). Introducing the peer pressure function is an attempt to explain differences in preferences and work ethics amongst workers. Making explicit assumptions about $P(\cdot)$ allows us to make statements about the tastes that drive particular behaviour.

The Cournot-Nash assumption that the actions of all other workers are taken as given is used. Each worker receives $\frac{f(\boldsymbol{e})}{N}$ in a pure partnership of size N. The actions of other workers (the a's) are assumed to have no effect on P and are therefore set to zero. The worker's problem becomes

[23] These are discussed in more detail later.

$$\max_{e_i, a_i} \frac{f(e)}{N} - C(e_i, a_i) - P(e_i, \ldots) \qquad \textbf{(15)}$$

with first-order conditions

$$\frac{\partial f / \partial e_i}{N} - C_1 - \frac{\partial P}{\partial e_i} = 0 \qquad \textbf{(16)}$$

given that a_i is set to zero.

Peer pressure implies that $\partial P / \partial e_i < 0$ (the disutility associated with peer pressure diminishes as workers exert more effort), which means that the level of effort that solves (16) is greater than the level of effort that solves (10). That is, effort is higher with peer pressure than without peer pressure. The $P(\cdot)$ function implies that workers get utility from effort. This has only been assumed, however. Workers working in an environment in which peer pressure exists may be worse off because of it. Peer pressure may increase effort, but it does not necessarily mean higher utility because pressure itself is a cost that is borne by all firm members. Despite the higher output that results from peer pressure, workers may not enjoy working in a high-pressured environment (Kandel & Lazear, 1992: 805).

3.4.2 Creating peer pressure

Considering the actions of organizations in the peer pressure function allows us to analyse how peer pressure is created and how partnerships result in higher effort levels.

The effectiveness of peer pressure as a motivator is conditional on two things: first of all, the effort of member *i* must affect the well-being of other team members in order for them to have the incentive to exert pressure on him. Secondly, team members must be able to affect the choices of member *i*. Profit-sharing in some form (or sharing of the incentive in the case of teachers) is required in order for the first component to hold. If workers are paid straight salaries, their level of effort does not impact on the salaries received by any of their peers, removing the incentive for workers to exert pressure on their peers since they are not concerned with the level of effort they choose. Profit-sharing is therefore necessary for peer pressure to provide motivation for workers to influence their peers' behaviour. However, it is not sufficient. Even if workers have reason to influence the behaviour of their peers, they need to be able to exert pressure for peer pressure to actually provide incentives. Both components are assumed to be created and manipulated to some extent by the education authority (Kandel & Lazear, 1992: 806).

Pressure can be classified as either internal or external. Internal pressure exists when workers feel disutility from hurting others, regardless of whether others are able to identify the offender or not. Sociologists call this "guilt". External pressure or "shame" occurs when disutility is dependent on others being able to identify the worker hurting others. The lack of observability implies that only guilt or internal pressure will be an effective form of pressure. Shame or external pressure requires that workers are able to observe one another's efforts. If a_j denotes the monitoring ability of workers, shame requires $a_j > 0$, while guilt would create pressure effectively for $a_j = 0$. Therefore

$$\frac{\partial P(e_i;\ e_{j,} \dots, e_N, a_i, a_j, \dots, a_N)}{\partial e_i} < 0$$

holds only when $a_j > 0$ in the case of shame, but holds for $a_j = 0$ in the case of guilt. The implication is that investment may be required to create guilt (Kandel & Lazear, 1992: 806 - 807).

Another aspect contributing towards the effects of incentives is empathy; if workers are monitored by people who are not members of the profit-sharing group, it is unlikely that workers will be motivated to behave efficiently.

N^* denotes the number of profit sharers that the individual cares about. The peer pressure function is defined $P(e_i, \dots, 0) = 0$, indicating that if the individual worker does not care about any peers, there is no relevant pressure. The maximization problem then becomes

$$\max_{e_i} \frac{f(e)}{N} - C(e_1, \dots) - P(e_i, \dots, N^*) \qquad \textbf{(17)}$$

where N is the number of individuals sharing the reward. N may consist only of members of the education authority. If workers do not empathise with them, then $N^* = 0$, in which case P = 0 and peer pressure would be useless as a motivating force. Allowing only the individuals with whom workers care to share in the rewards results in maximum motivation. $P(\cdot)$ therefore becomes endogenous in the sense that it becomes dependent on N^*, and it may be worthwhile to invest some resources in altering $P(\cdot)$ in order to improve incentives faced by teachers. The environment in which initial investments in loyalty are likely to be most effective and necessary is characterized by two features, namely the unobservability of workers' efforts and the complementarity of production (Kandel & Lazear, 1992: 807 - 808).

3.4.3 Mutual monitoring

In addition to exerting effort, workers are able to monitor each other and are able to penalize other workers caught shirking. For now, the punishment is assumed to be nonpecuniary (so it takes the form of physical or mental harassment) (Kandel & Lazear, 1992: 811). In this case, *a* can be thought of as peer monitoring. The expected penalty of being caught shirking now becomes

$$P(e_i;\ a_j,\ \ldots, a_n, N).$$

All workers are considered to be identical and so the monitoring decision of worker *k* is identical to that of worker *j*, which means the penalty may be written

$$P(e_i, (N-1)a_j).$$

The assumption of identical workers in the output function implies that *i*'s maximization problem becomes

$$\max \frac{f(e)}{N} - C(e_i, a_i) - P(e_i, (N-1)a_j) \qquad \textbf{(18)}$$

with first-order conditions

$$\frac{f_i(e)}{N} - C_1 - P_1 = 0 \qquad \textbf{(19a)}$$

and

$$\frac{N-1}{N} f_i \frac{\partial e_j}{\partial a_i} - C_2 = 0. \qquad \textbf{(19b)}$$

The choice of monitoring level *a* for each worker must satisfy (19b), according to which other workers respond to worker *i*'s choice of *a*. Workers generally believe that their co-workers will respond to their increased monitoring effort. Differentiating (19a) with respect to a_j will show the response of worker *j*'s level of effort to worker *i*'s choice of a_i, given that the problem is symmetrical across workers:

$$\left.\frac{\partial e_j}{\partial a_j}\right|_{(19a)} = \frac{-P_{12}}{\left(\frac{f_{ii}}{N}\right) - C_{11} - P_{11}}. \qquad \textbf{(20)}$$

The denominator of (20) is unambiguously negative, which means that the sign of the expression will be the opposite of the sign of the expected punishment, P_{12}. The expected punishment is related to the accuracy of detection – an increase in monitoring will presumably increase the accuracy of the measurement of co-worker effort, in which case those workers' levels of effort will increase, resulting in $P_{12} < 0$. P_2 does not enter, indicating that simply increasing monitoring efforts has no effect on the level of punishment. It is the *interaction* of increased monitoring and increased effort that accounts for $P_{12} < 0$, and simply increasing monitoring without allowing for this interaction (i.e. the worker's ability to avoid the higher punishment level by increasing their work efforts when co-workers increase their monitoring efforts) will have no effect. If we believe that increased monitoring will have no impact on worker efforts, then peer pressure loses its value as an incentive (Kandel & Lazear, 1992: 812).

The success in using peer pressure to incentivise teachers depends on the measure of success of the education authority in creating "guilt" amongst teachers. As the model shows, the number of workers that the individual cares about or who will share in the profits will influence the level of effort contributed by the individual. In the context of education, we may understand this to mean that when an incentive is provided for a whole school and not just for individual teachers, it is likely that the monitoring activities of teachers will be effective in enhancing the effort levels of their peers. Important to acknowledge when peer pressure creates incentives for workers is that it is only likely to results in increased effort levels if joint performance evaluation (as opposed to relative performance evaluation) is used to measure performance (Che & Yoo, 2001: 526). With relative performance evaluation workers are compared to their colleagues and are relatively worse off when their colleagues perform well given that relative performance evaluation rewards the highest performing workers within the organization. It therefore compares co-workers and so increased effort from one worker will "disadvantage" their colleagues. Relative performance evaluation therefore penalizes workers when their colleagues succeed (Che & Yoo, 2011: 529).

In settings where workers are likely to have "repeated interactions", or settings in which long term contracts are in place, the implicit incentives created by joint performance evaluation may prove useful. The implicit incentives arise as a result of the fact that workers are rewarded on the basis of both their own performance and that of their colleagues (Che & Yoo, 2001: 529), so hardworking co-workers increase the likelihood of reward which is not the case under relative performance evaluation. Furthermore, the possibility that shirking in the current period may be "punished" with shirking by co-workers in the next period or at a later stage is "selfenforcing" in the sense that workers "punishing " shirking co-workers in subsequent periods is not stipulated in any incentive contract and therefore does not need to be enforced by the education authority. Che and Yoo (2001: 231) explain that this is an endogenous characteristic of the relationship in a setting of joint performance evaluation and is likely to ensure that workers actually work (as opposed to shirk).

3.5 Return to distortion

The model discussed above indicates that introducing monitoring amongst teachers will in theory enhance their level of effort. However, it is not clear whether the expected increased earnings will result in an increase in human capital-enhancing teaching behaviour or behaviour that may be considered distortion. Therefore peer pressure does not necessarily result in improved long-term outcomes for students – the ultimate objective of implementing teacher incentives. Although peer pressure as an incentivising instrument may enhance the level of effort in a setting in which observability is limited, it does not remedy the problem of distortion in teaching behaviour.

Which features of the theoretical models discussed above should therefore be considered most important to successfully incentivise teachers to enhance their students' performance? Section 4 puts together a brief framework of the characteristics that enable incentive systems for teachers to result in improved performance for their students. Section 5 then presents international examples of teacher incentive programmes and analyses them according to the characteristics mentioned in section 4.

4. Characteristics of successful incentive programmes

Three aspects of incentive programmes need to be investigated when evaluating the likelihood of success: whether or not incentive programmes are likely to improve student outcomes through sorting or through enhanced effort; the risk of distortion that arises with the introduction of incentive programmes; and, in the case of low observability of worker effort (which is certainly the case in the teaching profession), whether an internal source of performance monitoring and accountability can be utilised to provide incentives (i.e. peer pressure). Each of these is discussed briefly below.

4.1 Sorting versus incentives

Whether or not incentive programmes are likely to result in improved performance depends on whether the programme results in higher levels of effort amongst teachers (assuming that increased teacher effort will result in improved student performance) or whether individuals better able to enhance student performance will be drawn to the teaching profession. Whether incentive programmes are likely to result in sorting or enhanced effort is an important question to consider because it is possible that the introduction of incentive programmes may have negative implications for poorly performing schools. Clotfelter, Ladd, Vigdor and Diaz (2004) examine this question in detail, using data from North Carolina. This aspect is discussed in more detail in section 5.

4.2 Potential for distortion

Another aspect to consider is the likelihood of distortion. The extent to which the introduction of incentives results in genuine improvements in learning as opposed to improvements in performance measures as well as the long term effects that incentives will have on student learning are important considerations. Neal (2011: 14) points out that even distortive behaviour may be a net gain in the case of extremely low productivity, in other words that teaching to the test may be better than no teaching at all. The risk for gaming behaviour as well as potentially short-term benefits should be investigated.

4.3 Possibility for peer pressure

The likely success of using peer pressure to incentivise teachers is dependent on teachers being able to monitor one another as well as being able to impose a penalty on workers who are found to be shirking. The combination of monitoring and penalising is important for this method of incentivising to be effective. Importantly, it requires that incentives be provided for the school and not for individual teachers.

How do incentive systems measure up internationally when evaluated according to the features highlighted in this section? Do they result in sorting or in enhanced teacher effort, and does this in turn result in improved student performance? Where improvement occurs, is this genuine human capital development or is it the result of gaming behaviour by teachers? Do the incentive systems in place enable the use of peer pressure as an incentivising mechanism?

Section 5 discusses incentive systems used in India, Israel, Kenya, Brazil, Chile, the USA and Finland, and analyses whether they are likely to fulfil the criteria outlined above.

5. International examples of incentive programmes

As mentioned above, this section discusses incentive systems implemented internationally. The last three incentive systems discussed in this section – those of the USA, Chile and Finland – are not analysed in terms of the framework laid out in section 4, but serve as examples of the risks associated with implementing incentive programmes (USA); the success with which pragmatic incentive programmes can be implemented in the context of a developing country (Chile); and the potential benefit that comes from incentivising the teaching profession through factors such as selectivity, prestige and relatively attractive compensation (Finland).

5.1 Andhra Pradesh, India (2005 – 2007)

A random control trial (RCT) conducted in India is an example of performance pay on an individual level based on student learning outcomes. In this study, individual teacher bonuses were awarded in 100 schools, bonuses were awarded to groups of teachers in 100 schools, an extra contract teacher was provided in 100 schools and a school grant was awarded to 100 schools. A further 100 schools were also included as a comparison group. The study was conducted over 2 years, and performance bonuses were promised to teachers at the beginning of the following school year (Muralidharan & Sundararaman, 2011). Bonuses were awarded to any teacher or school managing to increase student test scores by at least 5 percentage points, with higher increases being awarded with larger bonuses. Individual and group-level bonuses were paid at the beginning of the next school year, and block grants and extra contract teachers were provided unconditionally at the beginning of the school year.

At the end of the two year programme significant differences existed between individual- and group-level bonuses, as well as between schools receiving teacher bonuses and those receiving either block grants or extra contracted teachers. Individual incentives increased student performance on tests by 0.27 standard deviations (roughly 9 percentage points) in comparison with an increase of 0.16 (roughly 5 percentage points) for group incentives. Input strategies (block grants and extra contracted teachers) also improved student performance, but by a substantially smaller amount – 0.08 standard deviations.

During the study teachers were monitored by observers through unannounced classroom visits as well as interviews (Muralidharan & Sundararaman, 2011: 67). Teachers were monitored during 20 to 30 minute classroom observations in which enumerators coded whether or not certain actions took place in the classroom from a position at the back of the class, without interfering with proceedings. Teachers were then interviewed about their teaching methods and practices. The interviews took place at the end of the school year after testing had taken place but before results were available. Teachers were asked open-ended questions about how their teaching practices differed over the school year (Muralidharan & Sundararaman, 2011: 67 – 68). Although differences in classroom observations were not significant between treatment and control schools, teachers teaching in schools which received the incentives were significantly more likely to have given extra classes after school hours, to have focussed additional attention on weaker students, to have assigned more class work and more homework and to have given more tests as practice for exams. It is true that self-reported behaviour is less credible than classroom observations. However, the authors found a positive and significant relationship between teachers' self-reported behaviour and the performance of their students, suggesting that the teachers' reports were credible (Muralidharan & Sundararaman, 2011: 68). They conclude that although there was no difference in the proportion of teachers captured as "actively teaching" by classroom observers, it is likely that teachers increased the intensity of their teaching efforts (Muralidharan & Sundararaman, 2011: 69).

This study therefore provides evidence that teacher effort was enhanced by the introduction of incentives. The brief framework constructed in section 4 lists three criteria according to which incentive systems can be evaluated; whether incentive systems are likely to improve student performance through sorting in the teaching profession or enhanced teacher effort or both, whether incentive systems are likely to introduced distortion into teacher behaviour and whether peer pressure is a likely channel through which incentives can be implemented. Evaluating the incentive system introduced in Andra Pradesh according to this framework reveals that the incentives were effective in enhancing student performance through enhanced teacher effort. From the reported results it is difficult to see whether the performance gains were long-lasting and reflecting genuine skills development, or short term and reflecting an improvement in the performance measure. Although the gains were observed at the end of both years in the programme, students were not tested after the incentive programme had ended, and therefore it is not clear whether the effects of the programme outlasted its duration. The fact that teachers reported higher levels of practice tests and more extra tuition suggests that "coaching" may have been responsible for enhanced student performance. However, an increased focus on weaker students indicates higher levels of effort directed towards improving student human capital. Regarding the ability of group incentives to render peer pressure a viable channel through which incentives can be implemented, it is not clear whether teachers in Andra Pradesh used any kind of pressure or punishment to achieve increased effort levels. What we can see is that individual level incentives improved student performance by a greater margin than group level incentives, indicating that individual level incentives were more effective, although the group level incentives did also result in improvements in test scores.

5.2 Israel (2001)

Lavy (2009) presents evidence from a tournament-type bonus programme introduced in Israel in 2000. In 18 schools, teachers were ranked within schools based on their value-added contributions to the predicted matriculation marks of their students after controlling for socioeconomic characteristics, grade level, their level of study and school-level fixed effects. A control group of 18 schools was also included (Lavy, 2009: 1980). Teachers were ranked according to the deviation of the mean residual of the pass rate achieved by the students in their class, as well as the mean residual of the score that students achieved in various subjects (Lavy, 2009: 1983). Students who did not take the examination were assigned a score of zero but not excluded from the sample. The four top-ranked teachers in each subject (English and Maths were the core subjects, with awards being offered in other optional subjects) received an award that amounted to a substantial proportion of their salary (25% for teachers ranked first, 19.2% for teachers ranked second, 11.7% for teachers ranked third and 5.8% for teachers ranked fourth) (Lavy, 2009: 1983). Significant positive effects on student achievement were observed, with increases observed in test-taking amongst high school seniors, average scores and average pass rates in both mathematics and English. Although test-taking was optional, students who appeared on enrolment lists but did not take the test were given a score of zero but not excluded from the sample, therefore diminishing the incentive to discourage weak students from taking the exam (Lavy, 2009: 1983). Furthermore, given that the incentive programme was only revealed to teachers in the middle of the year (December 2000, with exams being written in June 2001), it is unlikely that teachers were able to influence the composition of their classes in order to ensure a stronger group of students (Lavy, 2009: 1982 – 1983). Teachers in schools for which the incentives were offered reported interesting modifications in their behaviour compared to teachers in control schools. Teachers in treatment schools were significantly more likely to track students by ability in the classroom (Lavy, 2009: 2004), to offer extra classes after school (Lavy, 2009: 2004) and to adjust their methods of instruction to the individual needs of the students (Lavy 2009: 2004). As a result, an increased proportion of students took the mathematics exam in schools in which the incentive was offered relative to to those in the control group.

Interestingly, it was observed that teacher effectiveness (as measured by their success in obtaining the bonus on offer) was not correlated to their observable characteristics (such as education level, gender, age, years of experience or certification level) but was correlated to the calibre of university that the teacher had attended (Lavy, 2009: 2004-2005). A significantly higher level of effectiveness was observed amongst teachers who graduated from top-ranked Israeli universities in comparison to those who attended teacher colleges or less prestigious universities.

This incentive programme is interesting to analyse in terms of the framework described in section 4. The results indicate that student performance did improve. Lavy (2009: 2004) reports that ability tracking, extra classes and focus on the specific needs of students was observed amongst teachers in both control and treatment schools, but that this behaviour was more prevalent amongst teachers who were offered the incentive. This suggests that the incentive programme encouraged increases in genuine effort and not merely "gaming behaviour". It is therefore unlikely that improvements in student performance resulted from gaming behaviour (Lavy, 2009: 2004). The observation that teachers who qualified at more prestigious universities performed better is an interesting and potentially important one. If individuals with the ability to perform well academically were the ones who attended prestigious universities, this may well indicate that there may be a potential to draw high ability individuals into the teaching profession through substantial monetary rewards attached to performance, as they are most likely to benefit from such a programme. This provides some support to the hypothesis that teacher incentives may enhance student performance through a process of sorting.

5.3 Kenya (1997)

Glewwe, Ilias and Kremer (2010) present evidence from an incentive programme run in 50 rural schools (with a control group of 50 schools) in Kenya. In-kind prizes (such as bicycles), which were valued at a significant proportion of a typical fourth to eighth grade teacher salaries, were awarded for improvements in average student performance over two years (Glewwe et al., 2010: 14). The prizes were awarded as group incentives, and performance was measured as improvements in baseline test scores obtained in Kenya's district-wide government exams. Prizes were awarded for "top-performing" schools and for "most improved" schools, schools being eligible for awards from only one of these categories. Three prizes each were awarded for first, second, third and fourth place, resulting in 24 out of 50 schools receiving prizes during the two years in which the programme was run. Teachers therefore felt that the reward was obtainable (Glewwe et al., 2010: 14).

A higher proportion of students in schools for which rewards were available compared to control schools achieved gains in test scores. By the second year, an average gain of 1.4 standard deviations was observed in treatment schools, with the largest effects being observed in geography, religion and history (roughly 0.34 standard deviations in the first year, and 0.20 standard deviations in the second year of the programme), followed by mathematics and science (with improvements of 0.20 and 0.15 standard deviations respectively) (Glewwe, Illias & Kremer, 2010: 29). However, these improvements did not persist. Differences in test performance had disappeared a year after the programme had ended. Glewwe, Ilias and Kremer (2010: 33) speculate that the introduction of rewards resulted in a short-run focus on improving test performance. They suspect, for example, that teachers may have focused more on short-term approaches such as increased coaching in test-taking techniques rather than an increased focus on pedagogical adjustments that may have resulted in longer-term learning gains. No evidence of behavioural changes was observed, with teacher absenteeism failing to decline over the period for which the rewards were offered (Glewwe, 2010: 20). There was also no evidence that more homework was assigned relative to the baseline year (Glewwe et al., 2010: 21). However, during the second year of the programme, schools that were eligible for rewards were more likely (by 7.4 percentage points) to conduct extra exam preparation classes (Glewwe et al., 2010: 22). Interestingly, when researchers changed the format of the exam from the format in which the government exams were presented, there was no difference in the performance of schools who were eligible for performance bonuses and control schools, suggesting that the benefits of increased exam preparation classes was limited to performance in the government exam, i.e. the target that teachers were aiming at (Glewwe et al., 2010: 30). It did not extend to more general learning. The authors report that there was no evidence of outright cheating amongst schools who received the incentive (Glewwe et al., 2010: 26). However, the fact that there was no significant difference between the performance of students in schools who received the incentive and those who did not when students wrote a different exam (one for which incentives were not provided) provides strong evidence that the improved student performance amongst students in the incentivised schools was probably not the result of genuine human capital development. Furthermore, the fact that improved performance did not continue after the termination of the incentive programme is a clear indication of the short-term focus of teacher effort (Glewwe et al., 2010: 29). There is therefore strong evidence of distortion in this incentive programme. The incentive programme did achieve improvements in student performance *on the performance measure*, but not on any other measure. The increased efforts of the teachers seem to have been directed towards gaming behaviour.

5.4 Pernambuco, Brazil (since 2008)

The Brazilian government's establishment in 2007 of the Index of Basic Education Development (IDEB) is central to Brazil's incentive structure that awards schools for improvements in student performance as well as other characteristics. IDEB captures school performance on Prova Brasil test results (a national assessment conducted every two years for all fifth, ninth and twelfth grade students in maths and language) as well as administrative data on enrolment, repetition and grade promotion (Fernandes in Bruns, Evans & Luque, 2012: 9). Importantly, IDEB results are reported widely in the Brazilian media and targets for each school within the 26 state and 5564 municipal school systems have been established by the federal government.

The state of Pernambuco implemented an incentive system in 2008 which rewarded school staff for the attainment of school improvement targets (Bruns, Filmer & Patrinos, 2010: 169). All teachers in schools achieving at least 50 percent of the target set by the federal government received bonuses proportional to their schools level of achievement. The size of the bonus is substantial by international standards since state education departments budget an additional month's payroll for the programme each year, and so if less than 100 percent of schools achieve the bonus, the mean bonus for those who do receive it will be greater than an additional month's salary. Schools achieving less than 50 percent of their target receive no bonus. School principals have no say in the distribution of the bonus, and the teachers in the school receive equal percentage bonuses on their monthly salaries (Parandekàr, Amorim & Welsh, 2008: 2).

The initial targets are established according to the quartile of the performance distribution into which schools fall, with performance targets being more or less ambitious according to the quartile. The differentiation of targets allows for an analysis of how achieving targets in one year impacts on the likelihood of achievement in subsequent years, as well as of how the achievement of targets and receiving a bonus is likely to impact on teacher behaviour (Parandekàr et al., 2008: 2).

The programme was widely accepted by schools in Pernambuco, where 64 percent of school principals indicated that the programme was appropriate and 66 percent indicated that they experienced the policy as having a positive impact on their schools, regardless of whether or not they received the bonus. Furthermore, schools for whom targets were more ambitious achieved greater student progress than those with less ambitious targets. Indeed, learning levels across the state increased substantially, with language score improving for the eighth and eleventh grade by 0.44 and 0.57 standard deviations over the period of a year, respectively. As the programme was applicable across the entire state, these gains are raw score gains and not gains relative to any comparison group. Schools that narrowly missed achieving the bonus in 2008 improved more in 2009 than did schools who barely achieved it. It therefore appears that not receiving the bonus improved school motivation and performance. Finally, schools in which teachers spent a larger proportion of time on instruction had a much greater likelihood of achieving the bonus (Bruns et al., 2010: 172).

Overall, teachers in schools achieving bonuses spent considerably less time on activities other than teaching and were also observed (in unannounced visits to the school) to make greater use of classroom resources (Bruns et al., 2010: 166). However, because of a lack of a "control group", the causality of "better" teacher behaviour cannot be inferred from the analysis conducted on the schools in Pernambuco. It is not clear whether the change in teacher behaviour reflects greater incentive to perform well or whether students in schools achieving the bonus are better students and easier to teach and manage. However, the fact that bonus achievers came from all parts of the performance distribution, including a substantial number of low-performing and low-income schools, suggests that the performance bonus may well induce improved teacher behaviour (Bruns et al., 2010: 174).

When the incentive scheme in place in Pernambuco is evaluated in terms of the framework introduced in section 4, it does not appear that sorting takes place. It is impossible to analyse whether individuals with higher ability entered the teaching profession. However, improvements were observed across the distribution of schools. This is probably the result of individualised targets for each school – a feature that should seriously be considered in the case of South Africa. When the possibility of distortion is considered, it seems fair to say that increased teacher effort may be directed towards ensuring improvements on the performance measure according to which teachers are evaluated. However, the fact that the performance measures are not limited to student test performance eliminates the possibility of distortive behaviour to some extent. It is possible that principals were dishonest in the reporting of enrolment and repetition rates, but the fact that these elements are included in the IDEB performance measure mitigates the risk of distortion to the extent that performance is not measured exclusively according to the Prova Brasil test results. The potential to make use of peer pressure as an incentivising force is heightened by the fact that incentives are awarded to a school and not to individual teachers. However, whether or not teachers are realistically able to monitor each other's behaviour and enforce punishment in the case of shirking is unclear from the results reported above. Group incentives do, however, heighten the probability that this will occur.

5.5 Chile (since 1991)

The System for Measuring the Quality of Education (SIMCE) was introduced in 1990 (Gustafsson, 2006: 3). The objective of SIMCE is the identification of schools in special need of intervention. The test is conducted yearly and involves the testing of an entire grade (approximately 300 000 learners) in either grade 4, 8 or 10 (alternated cyclically), ensuring that each grade is tested every three years (Gustafsson, 2006: 3). Importantly, the tests are marked at a single national centre and reports on the performance of individual schools are made available to the public (Delannoy, 2000: 17). Schools are compared within their region and within their socioeconomic category. It is argued that this encourages school principals to over-state the school's poverty level, therefore enabling the school to compete against poorly performing schools. Furthermore, poorly performing learners may be discouraged from attending school on the day that the testing takes place (Delannoy, 2000: 17). Teacher incentives in the Chilean education system have been introduced in phases. The first phase was introduced in 1991 with the Teacher Statute. It introduced a system designed to reward continued service as a teacher. Part of the monetary incentives introduced in Chile in 1991 were directed towards teachers in difficult-to-teach urban schools and remote rural areas (Gustafsson, 2006: 4). A 2003 regulation of the 1991 Teacher Statute details a 12 point index of school remoteness or difficulty, attaching various values to each indicator in order to ascertain the size of the incentive necessary to compensate for the remoteness and difficulty of the school. Provincial authorities then distribute earmarked funds as incentives through teacher salaries to those teaching in the most remote rural and otherwise difficult schools (Gusstafsson, 2006: 5).

The National Performance Evaluation System (SNED) was introduced in 1996, according to which all teachers in a well-performing school are rewarded. SNED is conducted biannually and is heavily reliant on learner performance data provided by SIMCE. Schools are compared within regions (of which there are 13) and within socioeconomic groups (of which there are 5), resulting in 65 groups in which SNED comparisons are made. The top 20 percent (approximately) of schools in each group are considered to be outstanding performers and receive additional funding for 2 years, 90 percent of which is paid to teachers as a monetary incentive, and 10 percent of which is allocated to schools and which may be spent according to the schools' own development plan. The money rewarded to teachers in outstanding schools amounts to approximately a month's salary, effectively providing a thirteenth pay cheque for them (McMeekin, 2000: 12).

SNED is based on a number of indicators and not solely on the learner performance data gained from SIMCE. These include value added (improvement in SIMCE scores since the last evaluation), school governance features and learner retention and graduation rates (Gustafsson, 2006: 5). Roughly half of all schools have received SNED incentives at some stage which means that the perceived likelihood of receiving an award is quite high. Rau & Contreras (2009: 24) provide evidence that student performance only improved in the portion of the schooling system which had received the reward. Student performance in large parts of the Chilean schooling system is unaffected by the teacher incentives system in place. Further research is necessary in order to understand how best to design incentive systems in a way that affects a larger proportion of students (Rau &Contreras, 2009: 25).

The Teacher Evaluation System was put in place in 2000. Evaluation occurs every four years, and involves four items: documentation from the teacher related to learner assessment, a series of the teacher's lesson plans, reflective notes produced by the teacher and a 40 minute video recording of a lesson. University-based evaluators then assess the material and classify teachers as excellent, competent, basic or unsatisfactory (Gustafsson, 2006: 5). A number of non-monetary incentives exist for good performance in the Teacher Evaluation System, one being the eligibility of good performers to participate in the Ministry's overseas experiential learning programme.

The Pedagogical Excellence Award (AEP) was also introduced during this phase. This award is a monetary incentive and it is relatively independent of the Teacher Evaluation System. Teachers are divided into four segments according to their years of teaching experience, with teachers in the first segment having between 2 and 12 years of teaching experience, teachers in the second segment having between 12 and 21 years of experience, and so on. A quota of AEP is established for each region, and the competition involves teachers submitting a portfolio of their methodology and writing a test covering both subject content knowledge and methodology. Winners receive a monetary award roughly equal to a month's salary for all the years in which they had been in their segment (Gustafsson, 2006: 6) Only a small group of teachers actually receive the award – 1500 received it in 2004 and 722 in 2005. It is clear, therefore, that the AEP has a very small reach. Teachers do not seem to consider it worthwhile to enter the competition. In addition to its role as an incentive programme, the AEP serves as a selection system for the Network for Teachers' Mentors, which is a remunerated programme. AEP recipients may therefore be seen to have a double monetary incentive, namely the financial award received for good performance as well as the opportunity to earn additional money as part of the Network for Teachers' Mentors (Gustafsson, 2006; Mizala & Romaguera, 2004).

Since 2005, teachers who achieve an "excellent" or "competent" rating on the Teacher Evaluation System can take a test administered on one day of the year at a national level (the same day as the AEP evaluations), according to which the Variable Allocation for Individual Performance (AVDI) is awarded for good performance. The AVDI amounts to between approximately 15 and 25 percent of the Minimum Basic National Pay. Teachers who are not yet eligible to be evaluated for AVDI may still apply for AEP (Gustafsson, 2006: 6).

Finally, a very interesting and controversial incentive in place in Chile is the Demerit List system. According to this system, a teacher receiving unsatisfactory ratings in the Teacher Evaluation System for three consecutive years, despite having received rigorous professional support and the assistance of an assigned tutor, will be dismissed and will receive a dismissal package. Importantly, teacher unions have agreed to this (Gustafsson, 2006: 6).

5.6 Incentive systems: What does the evidence say?

The incentive systems discussed above all provide evidence that introducing teacher incentives results in improvements in the measured performance of students. In the case of Andra Pradesh important adjustments in teacher effort were observed, although it is not possible to see whether the improved performance lasted beyond the duration of the incentive programme. An important result of the programmes is an increased focus on weaker students. In the case of Israel, teacher efforts were also found to increase. Interestingly, correlation between the positive effect of the incentive programme and student performance was observed most strongly for teachers from elite universities, suggesting the potential for more able individuals to benefit most from such incentive systems. Although improvements in the performance measure were observed after the introduction of teacher incentives in Kenya, the improvement could not be generalized to tests that were not included as part of the performance measure according to which teachers were rewarded. Furthermore, the improvement in test performance disappeared once the incentive system had been removed. Both of these observations suggest that gaming behaviour in the form of "teaching to the test" took place, rather than genuine skills development. The cases of Pernambuco and Chile illustrate the value of creating individualised incentives for schools. The fact that schools achieved improvements across the socioeconomic status distribution indicates the potential for system-wide improvement when the socioeconomic context of schools is taken into account. The Chilean example illustrates the possibility of introducing an element of fairness to incentive programmes by comparing schools within their socioeconomic status and within their region. In addition to ensuring fair competition, this also ensures that a large number of schools receive the award, therefore increasing the probability of receiving it. The fact that the AEP and the AVDI do not include measures of student performance may be perceived by teachers to increase the fairness of performance pay since their achievement is not affected by student performance which is widely known to be affected by numerous factors outside the teacher's control. However, while this eliminates the possibility of teachers behaving in a distortive way in order to qualify for rewards, it also means that teachers are rewarded on the basis of inputs rather than outputs. It is therefore possible that despite the fact that teachers perform well on these measures, they may not be able to enhance student performance. The AEP and AVDI are nevertheless useful programmes to enhance teacher pedagogical and content knowledge.

The two incentive programmes (from North Carolina in the USA and Finland) discussed below present examples of the potential risks and benefits associated with different incentive systems. The final example discussed – that of Finland – is presented as an example of an education system in which the absence of incentive pay does not compromise the performance of that education system.

5.7 North Carolina, USA

Clotfelter, Ladd, Vigdor and Diaz (2004) present evidence from North Carolina in the United States of America. The purpose of analysing the accountability system introduced in North Carolina is to highlight some of the risks associated with the introduction of incentive systems. North Carolina introduced an accountability system entitled ABC (A for accountability, B for basic skills and C for local control) in the 1996 – 1997 academic year (Clotfelter et al., 2004: 254). The accountability programme involves evaluating the gains in Maths and Reading scores from year to year, as well as the proportion of students performing at or above the grade appropriate level (Clotfelter et al., 2004: 255). Making use of the gain scores mitigates the disadvantages experienced by schools catering for students from low socioeconomic status communities, because it does not consider the level of test scores. Rewards are distributed at the level of the school, and a school's performance is evaluated relative to its expected gain for each year. This is calculated by adjusting the state average for the initial level of proficiency of the school's students as well as for mean reversion (Clotfelter et al., 2004: 255). A school is classified as having met its expected growth if the mean score of the students attending the school is at least as large as the calculated expected gain. Schools in which the mean student score is 10 percentage points higher than the calculated expected growth are classified as "exemplary", and schools not reaching their expected gain are classified as either "no recognition" or "low-performing" schools. "Low-performing" schools differ from "no recognition" schools because in the former, less than 50 percent of students performed at the appropriate grade level, whereas in "no recognition" schools at least 50% of the students performed at the appropriate grade level (Clotfelter et al., 2004: 255). Growth standards are therefore school-specific and low-performing schools are those that reached neither their school-specific growth standard, nor the 50 percent of grade appropriate performance standard. Financial bonuses of $1500 are awarded to teachers in "exemplary" schools (Clotfelter et al., 2004: 255). Schools results are made public on the ABC's website.

As mentioned earlier, this study provides interesting evidence of the potential negative implications of introducing incentive programmes. Clotfelter et al. (2004: 256) report that schools labelled as "low-performing" experienced a higher teacher turnover in the years following the introduction of the accountability system and subsequent classification. Interestingly, in weak performing schools in which less than 50 percent of students performed at the appropriate grade level but in which student test performance had met the expected test performance (and who were therefore not labelled as "low-performing"), teacher turnover did not change (Clotfelter et al., 2004: 258).

This example illustrates that labelling low-performing schools as such imposes additional "costs" on them in the form of higher teacher turnover. Higher teacher turnover makes it difficult to create continuity and momentum in reform efforts. This represents a challenge associated with rewarding some schools and not others: it may incentivise teachers to migrate away from weak performing schools towards better performing schools in which performance-related rewards are more likely. The extent to which this is a real risk depends on the ease with which teachers are able to move in and out of schools, and the extent to which teaching posts are available in schools classified as exemplary.

5.8 Finland

The Finnish education system is characterised by a very high level of equality, with schools performing in the lowest decile achieving average marks higher than the OECD median. It is therefore clear that educational quality is high throughout the Finish education system (August, Kihn & Miller, 2010: 18).

Selection into the teaching profession in Finland is highly competitive, and once candidates have been selected to enter the profession, they are required to obtain a master's degree in a five-year programme. Students must fall within the top 20 percent of their secondary school academic cohort. Students qualifying to apply to teach are examined in a first round of screening, after which only the top performers are invited to write an exam based on education literature. This is a further round of selection, after which top performers in the second exam are interviewed and screened on "softer" skills in order to ascertain whether they are likely to excel in the teaching profession. This third round of screening includes a "micro-teaching exam", in which students are evaluated in a classroom-like setting so that examiners are able to observe whether students work well with children (August, Kihn & Miller, 2010: 19).

Compensation for Finnish teachers is surprisingly modest, with teachers earning approximately 81 percent of per capita GDP (August, Kihn & Miller, 2010: 19). Performance pay and bonuses are not given to teachers. Graduate level training for teachers is paid for by the Finnish government, and students receive a living stipend. Interestingly, the complete absence of union politics within the Finnish teaching profession differentiates it quite substantially from the profession in other countries (Simola, 2005: 460).

Prestige is widely believed to account for the popularity of the teaching profession amongst top-performing students. Indeed, traditionally favoured professions such as lawyers, psychologists, physicians, engineers and journalists all trail teaching in terms of the number of applications at Finnish universities (Simola, 2005: 459). It is said that "people know that if you've been trained as a teacher you must be something really special" (Pasi Sahlberg in August, Kihn & Miller, 2010: 19). As a result of this signal of high quality emanating from the teaching profession, teachers have a substantial amount of autonomy in their work and are well-trusted by the public and the political and economic elite (Simola, 2005: 460). Teachers have a significant amount of authority in school policy and school management, textbook selection, course content, student assessment and budget allocations within schools and importantly, are left to teach the prescribed curriculum in the way that they see fit (August, Kihn & Miller, 2010: 19-20).

5.9 Potential costs of incentive systems and alternative solutions

The last two examples of international incentive systems (or in the case of Finland, a description of the factors that contribute towards the attractiveness of the teaching profession) have pointed out the possible risk associated with the introduction of incentive programmes to the teaching profession. In North Carolina the higher teacher turnover that resulted from the labelling of schools as low-performing schools with the introduction of the accountability programme had a negative effect that may not have been anticipated by the education authority. High teacher turnover makes it difficult to achieve any continuity and gather any momentum in school reform, therefore hindering the opportunity of these low-performing schools to improve their performance. This is a useful demonstration of the possibility that negative externalities may be associated with the introduction of incentives. In the case of North Carolina, "punishing" poor-performing schools may worsen their situation.

The Finnish example illustrates the possibility of ensuring high quality teaching without offering pay-for-performance incentives. The prestige of the teaching profession in Finland ensures that it remains a highly selective profession, admitting only high performing individuals into teacher training courses. Possibly as a result of this selectivity, teachers enjoy a high degree of trust and respect and have a large degree of autonomy in how the curriculum is taught. The superior performance of the Finnish education system is a testament to the high quality of teachers in Finland. The degree of selectivity and prestige observed in the Finnish teaching profession may be what is required for the achievement of the performance standards observed in that education system, and it is debatable whether their modus operandi is replicable in the context of a developing country context.

Section 6 discusses incentives systems from around the world, from both developed and developing countries. The first five examples of specific incentive systems provide evidence of their impact on student performance and teacher behaviour, while the last two provide examples of the potential costs associated with implementing incentive systems as well as an example of incentives inherent in the teaching profession (as opposed to those introduced through the implementation of an incentive scheme). These inherent incentives provide an example of sorting into the teaching profession. Are incentives likely to be effective in improving educational quality? What lessons can South Africa learn from these examples? What can we learn from international experience?

6. South Africa: where do we stand?

This section explores the lessons that South Africa might learn from international experience and analyses of the incentives inherent in the teaching profession in this country. It looks at the prospects for professionalising the teaching profession as a means of enhancing accountability within the profession and it examines the performance monitoring system currently in place in the South African education system, the Integrated Quality Management System (IQMS).

6.1 Lessons from international experience

The first four incentive systems analysed in section 4 (those of Andra Pradesh, Israel, Kenya and Pernambuco) illustrate the possibility for improvements in student performance through the implementation of incentive systems. In all cases, measured student performance improved with the introduction of the incentive system and the authors of the various studies (with the exception of the Kenyan case) indicated that the improvements appeared to result from genuine increases in teacher effort. The only study in which results were reported when the incentive system was no longer running (the Kenyan example) showed, however, that improvements in performance did not persist beyond the time period of the incentive system. Whether or not improvements in test scores were the result of gaming behaviour or genuine increases in teacher effort is therefore debatable. It still appears as if there is something to be said for incentives for teachers based on student performance.

An interesting aspect of incentive systems in place in Brazil and Chile, and one that is pertinent to the South African context, is dividing the education system into subsections in the setting of incentives. In the case of Chile, schools compete within their regional socioeconomic categories. In the case of Pernambuco in Brazil, school targets are set according to where they perform on the performance distribution. Given the extent of inequality in South Africa, comparing schools across socioeconomic quintiles would be grossly unfair. The educational and socioeconomic backgrounds of both students and teachers render comparison within socioeconomic groups a much fairer format for incentives used in South Africa. An appealing feature of the IDEB targets in place in Pernambuco is that they account to some extent for school-specific characteristics by setting targets at the level of the school. Consideration for the different circumstances across schools is crucial in the context of South Africa and should be part of any incentive programme if at all possible.

The unexpected outcomes of labelling poor performing schools as such are illustrated in the example of North Carolina's ABC accountability framework. Attracting teachers to teach in undesirable locations is already a problem in South Africa. Labelling schools as under-performing will probably exacerbate the problem, particularly if rewards are promised to teachers in schools that are publically recognised as performing well.

The Finnish example of illustrates the possibility of ensuring a high quality teaching force without explicitly introducing an incentive system. One of the key elements in the success of the Finnish education system is the prestige associated with the teaching profession. Section 4 details the competitiveness of teacher training courses in Finland, the high quality teachers that result from these courses and as a result, the high degree of trust and autonomy enjoyed by teachers. Perhaps the most startling feature of the teaching profession in Finland is the modesty of teacher wages relative to per capita GDP. This highlights the importance of the prestige associated with the teaching profession in ensuring a high-quality teaching force and brings to the light the "inherent" incentives in the Finnish teaching profession. .

The following section analyses the consequences of the lack of incentives for teachers in the South African teaching profession. Ironically, whereas the prestige of the teaching profession in Finland results in the profession's attractiveness despite the relatively low levels of remuneration, the relatively low levels of remuneration and prestige associated with the teaching profession render it a relatively less prestigious profession in the South African context.

6.2 Incentives inherent in the South African teaching profession

Although this chapter deals predominantly with explicit incentive programmes implemented to enhance student performance, it is important to recognise the incentives implicit in the salary structure of the teaching profession. Earlier sections discussed the possibility of attracting high-ability individuals to the profession through the implementation of incentives as part of an explanation for the "sorting" effect of incentives. Equally, if not more, important for the possibility of attracting high-ability individuals to the profession is their earning potential over the entire span of their career. An exploration of teacher incentives should therefore include a discussion of the incentives inherent in the profession, independent of those introduced with the express purpose of enhancing teacher effort.

An additional year of service in the teaching profession in South Africa is associated with approximately 1% increase in remuneration (Education Labour Relations Council (ELRC), 2011: 14). This appears to be the case "across the board" with every additional year of service. This is a point of contention amongst stakeholders. Each salary notch is 1% higher than the previous one. An REQV level 14 qualified teacher is employed at notch 85. It is possible for that individual to progress at a rate quicker than 1%, but if an REQV level 14 qualified educator remains a classroom based educator (post level 1). He or she will only have progressed to notch 125 after 40 years of service (ELRC, 2011: 14). Despite improvements in notch level progression[24], the slow rate at which teachers progress up the salary scale is problematic and will probably continue to cause dissatisfaction amongst educators.

The implication of this slow progression up the salary scale plays out in the type of individuals attracted to the teaching profession. Lortie (1975) explains the phenomenon of staging in remuneration for different professions. Staging refers to individuals within a profession receiving different levels of remuneration at different stages of their career. He explains that fields in which an individual's income increases substantially from one stage to the next usually reflect a significant change in status between different stages of the career. In contrast, in fields in which remuneration does not change significantly from one stage or phase to the next, differences in the status of individuals at different stages in their careers are less prominent and

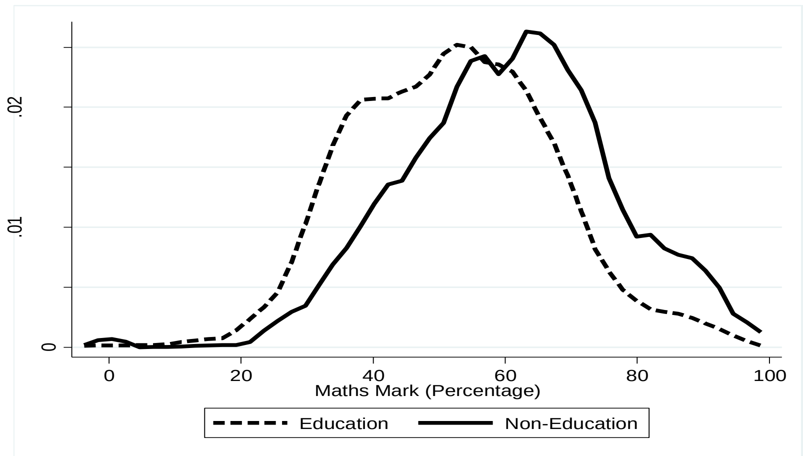
[24] Collective Agreement number 4 of 2009 allowed for notch progression based on years of service which saw an improvement in the salary progression of teachers who had been teaching for longer. For example, in 2007 teachers who had been teaching for 40 years with an REQV level 14 qualification earned just 29% more than entry-level teachers. The agreement saw these teachers earning 62% more than entry-level teachers in 2010. Similarly, educators with 11 to 15 years of teaching experience who were earning just 8% more than entry-level teachers in 2007 earned 26% more than this group in 2010 (ELRC, 2011).

in many cases, altogether absent for all practical purposes (Lortie, 1975). Teaching (particularly in the South African case) is significantly un-staged. This has particular effects on the occupation as a whole.

Remuneration for teachers may be considered "front-loaded" in the sense that very little progression from the initial salary notch happens over time. The salary level at which teachers begin is therefore high relative to their eventual earnings potential. In comparison to many other professions requiring a degree for entry (such as law, accounting and engineering), teaching can be described as being relatively "career-less" given that there is relatively little opportunity for upward mobility in terms of building a career. The status of a young entry level teacher is also not markedly different from that of a teacher with some experience in the profession (ELRC, 2011: 15).

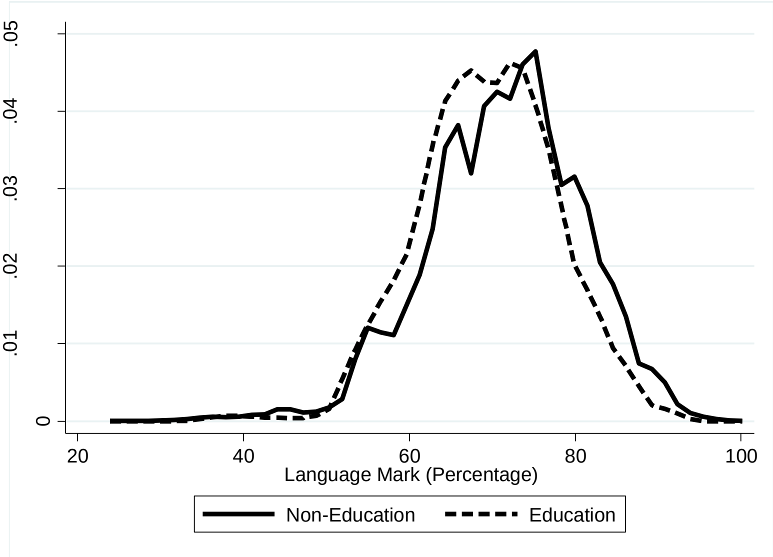
Overall the structure of teacher salaries (i.e. the lack of staging or marked progression up the salary scale for South African teachers) has consequences for the type of individuals who enter the teaching force. If staging remuneration within professions does indeed play the roles described above, then it becomes important to understand the probable impact that this will have on the profession as a whole. Evidence of this statement is provided by statistics about first year students enrolled in different faculties at the University of Stellenbosch (see figures 21 and 22).

FIGURE 21: Distribution of grade 12 mathematics marks for first years enrolments, 2005 – 2009



Source: Data on first year enrolment at the University of Stellenbosch, 2005 - 2009

FIGURE 22: Distribution of grade 12 language marks for first years enrolments, 2005 – 2009



Source: Data on first year enrolment at the University of Stellenbosch, 2005 - 2009

Figures 21 and 22 respectively show the performance in matric Mathematics and Language for students enrolled in the first year of university studies in the Education faculty and in the other faculties between 2005 and 2009. The figures show that the distribution of marks for students enrolled in the education faculty lie to the left of those of students enrolled in other faculties, indicating weaker performance in both mathematics and language amongst students enrolled for education training.

The inherent incentive in the salary structure of the teaching profession in South Africa does little to attract high ability individuals to the profession. The slow rate of progression through the salary scale provides little motivation for teachers to remain in the profession, particularly those with high earnings potential in non-teaching professions. In terms of sorting, therefore, it is unlikely that high-ability workers will be attracted to the teaching profession in South Africa.

6.3 Prospects for peer pressure as an incentivising force: Professionalising teaching

In terms of using peer pressure to incentivise teachers into exerting an acceptable amount of effort, section 3 referred to the possibility of professionalism within teaching as a vehicle through which “guilt” can be created. This subsection examines professionalization in the teaching profession, with a specific focus on the context of South African teachers.

Bennell (2004: 3) explains that in many low-income countries, teachers have a "semi-professional" status relative to occupations such as lawyers, engineers and doctors. This is largely the result of lower levels of education, relative to such professions, as well as a result of the size of the teaching force. "[T]he sheer size of the teaching force militates against professional exclusivity" (Bennell, 2004: 3). In many Sub-Saharan African and South Asian countries, teaching is considered "employment of last resort" and as a result, a fair number of teachers do not consider staying in the profession long term.

The ELRC's *Revised Salary Structure Proposal of 2011* indicates that teachers feel that their social and economic status have been eroded (ELRC, 2011: 28). There is a strong need amongst teachers to be recognised as professionals. There is a strong belief that the knowledge and skills requirements for teachers are equal to what is required in other professions, and that this is likely to be the case increasingly given that teaching now officially requires a degree for entry into the profession (ELRC, 2011: 28).

Pratte and Rury (1991: 64) describe professionalism as "an ideal to which individuals and occupational groups aspire, in order to distinguish themselves from other workers". The characteristics of a profession from which professionals derive their prestige are a) mastery of a distinctive body of knowledge, b) the control of membership of the profession and c) a commitment to the well-being of their client.

Professionals are expected to have expert knowledge in their field and the profession is largely based around identification with a distinctive body of knowledge. Organisations employing professionals function largely as communities of associates as opposed to being based on supervisory authority. The expertise of the professionals is the basis of their professional autonomy and authoritative power (Pratte & Rury, 1991: 66).

In terms of controlled access to the profession, the creation, diffusion and implementation of the professional standards of practice are assumed collectively by members of the profession. The licensing and to some extent the education of members is controlled by members of the profession and entrance into the profession (typically graduate level university study) is rationed to those achieving a minimum level of competency in their education up to that point. Having completed the academic programme, candidates are required to pass demanding tests of their theoretical knowledge as well as complete a kind of internship during which they are continuously evaluated. The function of controlling the membership of the profession therefore serves the function both of controlling induction into the profession and ensuring that the acquisition of knowledge is standardised across the profession (Pratte & Rury, 1991: 66).

Finally, professional practitioners commit to the pursuit of the welfare of their clients, usually through the acceptance of codes of ethics established by professional peers. Client dissatisfaction with the service of professionals is therefore dealt with through the initiation of a legal process rather than by reporting to the supervisor of the professional (Ambroise & Harley, 1988).

Lortie (1975) explains that the educational preparation of teachers is relatively general by comparison to that required by individuals entering into what are typically regarded as professions in the labour market. Teacher education does not require the same degree of intellectual rigour required in professions such as law, medicine or engineering. Education lacks the scientific roots or scholarly development that characterise those professions (Lortie, 1975); furthermore, teacher education and training takes place largely in the format of lectures and discussions, whereas traditional professions often require candidates to master the skills necessary for their professions in special settings such as laboratories. Teaching therefore does not require mastery of distinctive body of knowledge to the same extent that other widely recognised professions do.

Controlling access to the teaching profession in South Africa is not characteristic of “an ideal to which individuals and occupational groups aspire, in order to distinguish themselves from other workers” (Pratte & Rury, 1991: 72). Charles Simkins (2010: 11) reports that some 45% of new teacher registrations with the South African Council of Educators (SACE) in 2009/10 were provisional registrations given to teachers with less than the required qualifications. Therefore, a very large portion of individuals entering the occupation and being allowed to practise as teachers did not have the legally required qualifications (Simkins, 2010: 11). This stands in stark contrast to the pursuit of prestige and exclusivity inherent in controlling access to a profession.

South African teachers are exposed to approximately 150 to 160 practice teaching days (in the case of a 3 year teaching qualification), 200 to 220 practice teaching days (in the case of a 4 year teaching qualification) or 50 to 55 days (in the case of a 1 year postgraduate teaching qualification) over the duration of their teacher education (University of Stellenbosch, 2012). This is justification for Lortie’s (1975) observation that “one of the striking features of teaching is the abruptness with which full responsibility is assumed.” By comparison to professions requiring extensive residency or clerical work once formal education has been completed, the "internship" required by teachers is significantly less rigorous.

It seems then that teaching in South Africa (as in many other countries) is ill-fitted to professionalization. The nature of the knowledge required to enter the occupation and the absence of the rigorous entry procedures that exist for other professions make it difficult to justify a call for the professionalization of teaching in its current state. The teaching profession would have to be "recast" as one requiring rigorous preparation and one which holds a fair amount of prestige. Countries in which teaching is considered a prestigious profession have, however, achieved phenomenal educational success.

In the absence of strong professionalism, peer pressure may incentivise teachers if ways can be found in which teachers can monitor one another's behaviour and exert pressure on teachers who do not exert the required amount of effort, and if this pressure is likely to result in a change in behaviour.

Section 6.4 explores the monitoring system currently in place amongst South African teachers and considers the probability that such monitoring would result in increased effort amongst teachers.

6.4 Mutual monitoring: The Integrated Quality Management System

In the absence of professionalization, peer pressure is created through mutual monitoring of workers. The use of peer pressure to enhance effort levels requires that monitoring by peers actually results in enhanced effort. The possibility of imposing punishment on team members who do not pull their weight should therefore exist.

Currently, the system whereby teacher performance is measured and recorded in South Africa is the Integrated Quality Management System (IQMS). The IQMS handles teacher evaluation through self-evaluation by teachers and through a development support group (DSG) (ELRC, 2003). The self-evaluation and the evaluation conducted by the development support group use the same instrument so that teachers are familiar with the criteria according to which they are to be judged. The DSG is comprised of the teacher's immediate senior (i.e. head of department, or deputy principal in the case of a head of department) and one peer in their field of specialisation. They may choose which of their peers they would like to be part of the DSG. Teachers are graded according to 12 performance standards and both the self-evaluation and the evaluation conducted by the development support group are considered in the overall evaluation. The evaluation happens once every year and its primary objective is to help teachers develop growth plans (ELRC, 2003). Teachers are therefore involved directly in monitoring the performance of their peers. The procedure is intended to have a nurturing and developmental role, however, and is most definitely not designed to enable teachers to apply any kind of pressure or disciplinary actions against their peers. Furthermore, the fact that teachers are allowed to choose the peer who will form part of the DSG provides the opportunity for teachers to influence the type of assessment they may receive from the group members. Although it is stipulated that educators must appoint peers from their field of specialisation, there are no other requirements or restrictions on who teachers may choose to be part of the group. It is therefore possible that teachers will choose peers most likely to provide them with a good assessment. In this way, distortion may occur as a teacher is able to influence the outcome of the performance measure, albeit indirectly.

Peer pressure as a mechanism for incentivising teachers is unlikely to prove effective in the present system. Because it is a once-yearly exercise and because teachers choose their assessors, it is highly unlikely that teachers will be able to exert any kind of pressure on their co-workers, or that increased monitoring will result in higher effort levels.

6.5 Inequality prevails

A common problem with teacher incentives and one which is particularly relevant in the South African context is that evaluation depends on student performance on standardised tests. A strong argument against using such measures for evaluation is that student performance is significantly affected by many factors outside the classroom and the school and therefore outside the teacher’s control. It is seems grossly unfair to rank and reward teachers according to a measure that is to a large extent outside their control. Also important in South Africa is the issue of inequality and fairness. South Africa’s history of inequality, particularly in the education sector, resulted in substantial differences in the quality of the training received by teachers from different race groups (Van der Berg, 2006: 3). Furthermore, the endurance of the apartheid legacy in educational quality means that awarding incentives based on student performance is simply not fair. Teachers cannot be judged on the performance of their students alone.

Chapter 3

The impact of teacher characteristics on student performance: An analysis using hierarchical linear modelling

1. Introduction

The impact of teacher characteristics (both qualifications and demographic characteristics) is important for education policy. Ensuring that teachers best suited and most able to enhance student performance are employed is a key responsibility for policymakers. Wayne and Youngs (2003: 89) explain that a large body of literature about teacher characteristics and education outcomes exists. The focus on the studies vary between questions about teacher quantity and turnover and issues surrounding teacher quality. In many countries (South Africa included) certain qualifications need to be obtained before teachers are permitted to enter the teaching force. Much of the literature surrounding teacher characteristics and student performance is comprised of analyses of the impact of these and other qualifications. Attempts have been made to identify trends in the quality of teachers, and the question whether characteristics of teachers in different parts of the schooling system exist is often investigated (Wayne & Youngs, 2003: 90).

The relationship between teacher characteristics and student performance is surprisingly elusive, however. Researchers have found it difficult to find aspects of teacher training that correlate with student performance in a statistically significant way (Chingos & Peterson, 2011: 449). Conflicting or indeterminate results occur often. Summers and Wolfe (1977) investigated the impact of teacher scores on "Philadelphia's National Teacher Evaluations" on performance amongst primary schools students in that state, finding a negative relationship between teacher performance and student scores on standardised tests. Anderson (2000) investigates the determinants of student performance in mathematics and language in Mexico and finds a positive and statistically significant impact in both mathematics and language for teachers making use of a more interactive approach to teaching as opposed to a traditional approach in which lessons are dominated by teachers talking and instructing (Anderson, 2000: 144). She also finds evidence of a positive relationship between hours spent teaching and performance in both subjects[25] (Anderson, 2000: 145). Teacher effort variables therefore impact positively and statistically significantly on student performance. An interesting and important result is the positive and significant impact on both language and mathematics observed for teacher training during the year in which the study was conducted (Anderson, 2000: 146). Angrist and Lavy (2001) find positive estimates of the impact of in-service teacher training on both mathematics and language in secular primary schools in Jerusalem. They report that their results are robust to a number of estimation techniques, namely regression, difference-in-difference techniques as well as matching techniques. The fact that the effect is only observed in secular schools may be due to the fact that the training programme was introduced later and on a smaller scale in religious schools (Angrist & Lavy, 2001: 365).

Ferguson (1998) used data from the "Texas Examination of Current Administrators and Teachers" to evaluate the impact of student performance at all levels of the schooling system. Contrary to the results obtained by Summers and Wolfe, Ferguson found a positive correlation between student performance and teacher test scores.[26] The relationship between teacher performance on tests in the subject they teach and student performance in that subject has also been tested extensively. Positive associations between teacher test score and student performance are observed in some studies across a range of subjects (Ehrenberg & Brewer, 1995; Hanushek, 1992; Rowan, Chiang & Miller, 1997), while others find a negative impact of teacher test scores on student outcomes (Murnane & Phillips, 1981). It seems then that the evidence regarding the impact of teacher content knowledge on student outcomes is mixed. Results obtained for formal teacher qualifications were also mixed, with the majority of studies conducted returning indeterminate results. Amongst those that did return results, both negative and positive impacts were observed (Wayne & Youngs, 2003: 101-103). The existing research therefore leaves us with few answers to questions about the relationship between teacher qualifications and student performance. Indeed, are teacher qualifications important at all?

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[25] Anderson notes that this variable is self-reported (Anderson, 2000: 145) and may well be over-reported. However, if this is the case, it likely that the coefficient on this variables is a lower bound of the effect of time on task of student performance.

[26] Important to note is that Ferguson's study aggregated data to the district level. Hanushek, Rivkin and Taylor (1996: 616) explain that aggregating data to a "higher" level (i.e. school, district or state level) increases the likelihood of obtaining positive results.

Evidence from Pakistan suggests that teacher qualifications are indeed important for student performance. Arif and Saqib (2003) control for the individual and family characteristics of students, the characteristics of the schools they attend, geographic characteristics as well as a range of teacher characteristics and find that whether a teacher has a bachelor's degree or higher is positively and statistically significantly associated with student performance in language, mathematics and general knowledge as well as a measure capturing performance in all three (Arif & Saqib, 2003: 19-20). An earlier study conducted in Pakistan (Behrman, Kahn, Ross & Sabot, 1997) construct teacher quality indices for language and mathematics. These indices are linear functions of teacher performance on literacy or numeracy tests, educational attainment, and teaching experience and its squared term (Behrman et al., 1997: 131). Controlling for student demographic characteristics and family background, school characteristics, student-teacher ratios and student ability, they find a positive and statistically significant relationship between the teacher quality index and student performance in both numeracy and literacy (although the effect seems to be larger in literacy – an interesting result, since an effect, if observed at all, is usually stronger in the case of mathematics) (Behrman et al., 1997: 133).

Another study that finds a relationship between observable teacher characteristics and student performance was conducted by Slater, Davies and Burgess (2009) using UK data for 7 000 students (14 year olds) writing GCSE Keystage 4 examinations.[27] Slater et al. (2009) investigate whether the observable characteristics of teachers are correlated with measures of teacher effectiveness. Teacher effectiveness is measured as the effect that teachers have on student performance on the examinations. The observable characteristics available are teacher gender, age, educational attainment and teaching experience. None of these characteristics are statistically significant in explaining teacher effectiveness (Slater et al., 2009: 12). Interesting to note, however, is that Slater et al. (2009: 13) find a correlation (albeit weak) between the ability of students and teacher effectiveness, suggesting non-random allocation of students within a school. Allocating students to teachers in such a way that places less able students with more effective teachers may well enhance the positive impact of teacher effectiveness.

[27] Keystage 4 examinations are compulsory examinations dictating entrance to post-secondary education. These are written at age 16. Keystage 3 examinations are written at the beginning of Keystage 4 programme during the year that students turn 14 (Slater, Davies & Burgess, 2009: 4). Keystage 3 examinations are often used as a "pre-test" measure in education research, or an as indication of prior attainment.

Raudenbush, Eamsukkawat, Di-Ibor, Kamali and Taoklam (1993) investigate whether in-service training affects student performance significantly. They measure in-service training by including a variable capturing the amount of exposure (in terms of days) of in-service training as well as a variable controlling for the number of times that teachers received internal supervision (Raudenbush et al., 1993: 286). They also include a measure of whether a teacher has a bachelor's degree. They come up with a very interesting result: although in-service training does not appear to have any significant effect on student performance, internal supervision (by the school principal or another teacher at the school)[28] has a large and significant effect. They explain the effect of intensive internal supervision as being as large as a teacher obtaining a bachelor's degree (Raudenbush et al., 1993: 294). It appears then that although formal in-service training does not appear to improve teacher quality, a type of mentoring and "coaching" approach does. Results from a study conducted using Cambodian data (Marshall, Chinna, Nessay, Hok, Savoeun, Tinon & Vaesna, 2009: 406) show positive and significant effects (as well as inequality reducing effects) on the performance of grade 6 students on language tests. High levels of mathematical content knowledge amongst teachers also showed a positive and significant effect on grade 6 mathematics performance and high levels of mathematics pedagogical content knowledge had a significant impact on grade 3 mathematics performance (Marshall et al., 2009: 406). The authors did not control for formal teacher qualifications or teaching experience separate to content knowledge. Luschei and Carnoy (2010: 175) find no significant impact for teachers' postgraduate education on student performance in mathematics or language in a study conducted using Uruguayan data. Interestingly, however, high levels of teaching experience (10 years and above) are positively and significantly associated with both mathematics and language performance (Luschei & Carnoy, 2010: 175-176).

Another study that finds a statistically significant relationship between teaching experience and student performance is that of Clotfleter, Ladd and Vigdor (2007). These authors use North Carolina data to investigate the relationship between teacher characteristics and student performance. Since the early 1990s, the state of North Carolina has administered standardised mathematics and reading tests to all students between grades 3 and 8 (Clotfelter et al., 2007: 675). Furthermore, it is possible to match students to their teachers for each year. The authors are able to identify the teachers of at least 75% of grade 3, 4 and 5 students in the state's

[28] This is in contrast to external supervision by a district official (Raudenbush et al., 1993: 294) which shows no significant impact on student performance.

education system between 1993/1994 and 2003/2004, rendering it possible for them to conduct analysis on the impact of teacher characteristics on both the levels of mathematics and English performance and the gains in performance from year to year (and therefore controlling for various student and school-level effects, the gains that may be tentatively associated with the teacher) (Clotfelter et al., 2007: 675). The authors find a positive and statistically significant impact for teacher experience on student performance in both mathematics and English (Clotfelter et al., 2007: 676).[29] The size of the coefficients indicate that the majority (or more than half) of the returns to teaching experience occur within the first two years of teaching. An issue often raised when investigating returns to teaching experience is the possibility that positive returns to experience are overstated if it is likely that underperforming or weaker teachers will leave the profession after their initial year (Rockoff, 2004: 248). The authors test for this possibility by adding a variable controlling for whether a teacher remained in the profession in North Carolina for at least three years. They interact it with the categorical variables controlling teachers with 1 to 2 years of teaching experience. If weaker teachers leave the profession after their early years as teachers, a positive coefficient on the variable controlling for those who remain in the profession is expected. However, the opposite is observed. In the case of mathematics, a negative and statistically significant coefficient is observed in both the levels and gains model, suggesting that those who leave teaching are not less able than their counterparts who remain in the profession. Furthermore, the interaction term is not statistically significant in either subject, suggesting that it is not differential attrition that drives the increasing returns to teaching experience observed in the data (Clotfelter et al., 2007: 676).

"By many accounts, the quality of teachers is the key element to improving student performance" (Hanushek, 2009: 171). The impact of being taught by a good teacher is quantified by Hanushek (2011: 42) where he estimates that students who perform a standard deviation above average (as measured by performance on high school tests) earn between 10 and 15 percent more per annum than average – an estimate he deems conservative as it is measured in the early years of their career (before they have reached their full earning potential) and it does not account for the possibility that higher performance at high school level probably

[29] Teacher experience is captured by categorical variables denoting 1 to 2 years of experience, 3 to 5 years of experience, 6 to 12 years of experience, 13 to 20 years of experience, 21 to 27 years of experience and more than 27 years of experience. They therefore control for non-linear returns to teaching experience (Clotfelter et al., 2007: 676). The returns observed are higher for mathematics than they are for English – a finding largely in line with what is found in the literature about teaching experience and student performance.

results in higher educational attainment (Hanushek, 2011: 42). The home background and motivation of the student obviously contribute significantly to the level of success that students are able to achieve, but rigorous research has isolated the impact of effective teaching on student performance. Hanushek (2011: 42) reports that studies have consistently shown that high-performing teachers (performing 1 standard deviation above the mean, or at the 84th percentile of the distribution) result in student grades that are at least 0.2 standard deviations higher at the end of a school year. Although these gains diminish over time, it is estimated (although somewhat less conclusively) that the long term benefit of being taught by an effective teacher is 70 percent of the immediate gain, and so consecutive years of high quality teachers result in student outcomes markedly higher than they would have been had students been taught by teachers at the 50th percentile of the distribution (Hanushek, 2011: 42). It is clear then teacher quality and teacher effectiveness have a considerable effect on the lifetime earnings of students.

Evidence of the impact of teacher quality in later life also exists. Chetty, Friedman and Rockoff (2011) find evidence of fairly sizeable impacts of teacher quality on adult earnings of their students. Teacher quality (measured by value added) improves the probability of college attendance, the quality of college attended by students (measured by the earnings of former students of colleges) as well as future earnings of students (Chetty et al., 2011: 2).

How then should we measure teacher quality? To what extent are we “missing the point?” An important aspect of teacher quality and teacher effectiveness to consider is the extent to which the education received by teachers is well-suited to enabling them to teach. A significant literature (some of which is discussed above) exists around whether teaching is an attractive profession to highly able individuals endowed with skills that fetch a high price in the labour market. It is important to understand whether or not those skills are likely to translate into positive outcomes for students or whether there is “something else” required of teachers that does not necessarily guarantee that highly able individuals will be effective teachers. One way to approach this question is to investigate the specific knowledge requirements of teachers.

The National Council of Teachers of Mathematics in US (NCTM) refers to teacher’s knowledge of their students as students as being central to their ability to influence their performance (NCTM, 2000: 17). This broadly refers to teachers being able to identify “preconceptions and background knowledge that students typically bring to each subject” (National Board for Professional Teaching Standards (NBPTS), 2012: vi). This is essentially what is referred to as Pedagogical Content Knowledge (PCK) (Hill, Loewenberg Ball & Schilling, 2008: 373). Although its importance in improving student outcomes is widely acknowledged, very little exists in the way of empirical evidence and understanding of this relationship. Hill et al. (2008: 373) believe that this results from two factors. Firstly, there is an absence of studies that are able to prove that teachers possess such knowledge, and secondly, measures to assess programmes which aim to develop this knowledge and its impact on student achievement have not yet been developed. In the absence of such measures, it may be difficult to measure the aspect of teacher quality that truly affects student performance.

Research that does investigate the type and depth of subject (and other) knowledge required to teach presents some very important results. The mathematical knowledge required of mathematics teachers is extensive (Ball, Thames & Phelps, 2008: 399). The tasks involved in teaching mathematics require "significant mathematical knowledge, skill, habits of mind and insight" (Ball et al., 2008: 399). What is referred to as *common content knowledge* is the mathematical knowledge that teachers require to perform their job. Teachers also require *specialised content knowledge* – mathematical knowledge and skills particular to teaching. This type of mathematical knowledge is not particularly useful (or even desirable) outside the context of teaching and requires a certain "unpacking" of mathematical knowledge. Examples of this kind of mathematical content knowledge would be the analysis of student errors or evaluating whether a nonstandard approach to calculation would work in general (Ball et al., 2008: 400). A third domain, *knowledge of content and students*, involves understanding and therefore anticipating how students will interpret and understand the work and where they will experience difficulty (Ball et al., 2008: 401). The fourth domain, *knowledge of mathematics and teaching*, refers to an understanding of how mathematics should be taught. For example, the sequencing of topics and examples would fall under this category of mathematical knowledge (Ball et al., 2008: 401). The authors point out that the mathematical knowledge required of teachers (and indeed teachers across different fields and subjects) includes and extends beyond that of other professions requiring mathematical knowledge. This is important to acknowledge this when evaluating the importance of the profession in society.

A rare study in which the impact of different kinds of mathematics knowledge amongst teachers (based to a large extent on the findings of Ball et al. discussed above) was tested amongst students attending schools in rural Guatemala (Marshall & Sorto, 2012) presented encouraging results. Using hierarchical linear modelling, they test the impact of different kinds of teacher knowledge in different areas of mathematics performance. Interestingly, they find coefficients of very similar size to those observed in US studies. Marshall and Sorto (2012: 188) find significant results for what they call "mathematics knowledge for teaching" (as opposed to common content knowledge and specialised content knowledge). Interestingly and importantly, the coefficients for mathematics knowledge for teaching are largest and most significant for areas of the mathematics test that have the highest degree of cognitive demand required of students (Marshall & Sorto, 2012: 191). This makes intuitive sense – the more difficult the content, the more specialised a teacher needs to be to ensure that student learning takes place.

In a South African context, Fleisch (2004: 264) finds inconclusive results regarding the relationship between higher levels of teacher resources and student performance. However, Fleisch explains the importance of understanding the absence of the relationship. Indeed, if education policy aims to improve the state of education through changes around teacher policy, then caution must be exercised when considering this policy (Fleisch, 2004: 264). Qualitative research on what happens in schools is required in order to understand how teachers can be best utilised to improve education outcomes. Other South African research by Crouch & Mabogoane (2001: 64-65) finds a strong correlation between teacher qualifications and student performance on matric (grade 12) examinations. As a result, these authors suggest the possibility of upgrading teacher qualifications as a means to improve student outcomes (Crouch & Mabogoane, 2001: 75).

This chapter aims to investigate which characteristics of South African teachers, both demographic and in terms of qualifications and teaching experience, impact on student performance. The chapter is organised as follows: section 2 defines the research question, introduces the dataset that will be used in the analysis, SACMEQ III, and provides the descriptive statistics of the variables that will be included in the model. Section 3 discusses the necessity for hierarchical linear modelling, while section 4 presents the model that will be specified in attempting to answer the research question. Section 5 presents the results obtained from the model, and section 6 concludes with a discussion of the possible driving factors behind these results.

2. Research question and data

2.1 Defining the research question

As indicated, this research aims to answer the question of whether teacher characteristics (both demographic and human capital) impact student performance. As explained, South Africa's educational performance is weak. The question we attempt to answer in this chapter is whether this weak performance can be explained by observable teacher characteristics. In order to measure the impact of these characteristics, the fact that students share "teacher characteristics" with the students in the same class means that the assumptions that would render ordinary least squares (OLS) regression coefficients accurate (i.e. that students are drawn from a random sample) are violated. The multi-level nature of the data requires that this element be controlled for and modelled in the investigation. This is discussed at length in section 3. In summary, the confidence intervals that would result from OLS would be deceptively narrow as a result of inaccurately small standard errors (Arnold, 1992: 62). Students being taught by the same teacher not only share "teacher characteristics", but are also more likely to be more similar to one another than to students taught by different teachers. This further violates the assumption of students being drawn at random (Arnold, 1992: 62).

The following subsection explains the data used to conduct the analysis – the third study conducted, in 2007, by the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ III).

2.2 Data: SACMEQ III

The paper makes use of data collected by the third study conducted by SACMEQ in 2007. SACMEQ was launched in 1995 with the objective of conducting research and providing training that enables policy makers to monitor and improve their education systems (Moloi and Strauss, 2005: 12). SACEMQ undertook 3 major surveys (referred to as SACMEQ I, II and III) in 1995, 1998 and 2007 respectively. 15 countries participated in SACMEQ III, namely Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania (Mainland and Zanzibar), Uganda, Zambia and Zimbabwe (Spaull, 2011b: 4).

SACMEQ III involved administering 3 tests to grade 6 students - a reading test, a mathematics test and a health test (aimed largely at measuring the level of knowledge about HIV/AIDS). In

South Africa, 9 038 grade 6 students in 392 schools were tested, along with 498 mathematics teachers, 498 reading teachers and 492 health teachers (totalling 1 488). All the teachers completed a health test, and reading and mathematics teachers completed a test in the subject that they taught (Spaull, 2011b: 5).

The data obtained from SACMEQ III comprise the most extensive nationally representative sample available for the South African education system.[30] Importantly, the testing was only conducted in English and Afrikaans. It is therefore highly likely (if not certain) that a significant proportion of the students writing the tests were disadvantaged in terms of understanding the mathematics questions, given that neither English nor Afrikaans was their first language. The extent to which English is spoken outside of school is controlled for at the student level but the dataset did not contain the corresponding variable for Afrikaans. It is worth noting, however, that the aforementioned language disadvantage applies to the majority of students tested in South Africa (Moloi and Strauss, 2005: 67).

Importantly, in any analysis of performance in education making use of cross-sectional data that does not contain a pre-test score, unobservable characteristics of students (such as motivation or intelligence) which influence their performance on mathematics tests are therefore not controlled for. It is also important to bear in mind that the impact of teachers on students' education is cumulative. The results observed in grade 6 therefore reflect the impact of teachers throughout students' educational "career" and cannot be attributed only to the teachers by whom students are taught in that year. Having said that, we do not have a pre-test score and we are therefore not able to control for students' ability or level of performance before their exposure to their current teacher.

2.3 Variables included in the model

Table 5 below provides a brief explanation of the variables included in the investigation as well as the means and standard deviations. The dependent variable, $ZMAT_{ij}$, is the z-scored (standardised) mathematics score of student i in classroom j. Z-scoring the dependent variable centres the variable around a mean value of 0 and gives the variable a standard deviation of 1.

[30] Mullens, Murnane and Willett (1996: 140) explain the need for longitudinal data in assessing the impact of teachers on student learning. In the majority of studies investigating this topic in the developing world, longitudinal data are not available and so researchers have no choice but to use cross-sectional data. Cross-sectional data can only tell us about the level of student achievement and not about the progress that takes place (i.e. the actual learning). However, data on changes in achievement are necessary to truly evaluate the effectiveness of teachers (Mullens et al., 1996: 140).

The interpretation of coefficients on independent variables for z-scored dependent variables is the standard deviation change in students' mathematics performance.

TABLE 5: Description and descriptive statistics for variables included in the model

Variable	Mean	Standard deviation
STUDENT LEVEL VARIABLES		
Continuous variables:		
Mathematics score (z-scored; standardised to the mean within the South African dataset)	0.00	1.00
SES (z-scored; standardised to the mean within the South African dataset)	0.00	1.00
Dummy variables (takes a value of 1 if true; takes a value of 0 if not true)		
Overage (born earlier than 1994)	0.19	0.39
Female (reference value: 0)	0.51	0.50
Mother has completed matric	0.51	0.50
Attended less than 1 year of preschool	0.05	0.21
Attended 1 year of preschool	0.33	0.47
Attended 2 years of preschool	0.15	0.36
Attended 3 or more years of preschool	0.2	0.40
Speaks English at home sometimes	0.61	0.42
Speaks English at home most of the time	0.08	0.49
Speaks English at home always	0.07	0.26
Repeated a grade once	0.20	0.40
Repeated a grade twice	0.05	0.22
Repeated a grade three times	0.03	0.17
Repeated grade 6	0.09	0.29
Receives extra tuition	0.09	0.29
TEACHER LEVEL VARIABLES		
Continuous variables:		
Days of in-service training	13.04	46.04
Average class size (of the school)	40.79	12.6
Teacher maths score (z-scored; mean of 0 and standard deviation of 1)	0.00	1.00
Average classroom SES (z-scored; standardised to the mean within the South African dataset)	0.18	0.80

Dummy variables:		
30 to 39 years of age	0.39	0.49
40 to 49 years of age	0.44	0.50
50 to 59 years of age	0.14	0.34
60 years and older	0.01	0.09
School is in a rural area	0.38	0.49
Private school	0.05	0.22
Trained to teach mathematics	0.67	0.47
Parents sign students' homework	0.59	0.49
Test 2 to 3 times per term	0.52	0.50
Tests 2 to 3 times per month	0.22	0.42
Tests at least once per week	0.15	0.36
Completed junior secondary education	0.02	0.15
Completed senior secondary education	0.09	0.29
Completed A-levels[31]	0.16	0.37
Completed a degree	0.51	0.50
Received less than 1 year of teacher training	0.01	0.08
Received 1 year of teacher training	0.02	0.15
Received 2 years of teacher training	0.07	0.25
Received 3 years of teacher training	0.34	0.47
Received more than 3 years of teacher training	0.56	0.50
Experience: 6 to 10 years	0.11	0.31
Experience: 11 to 15 years	0.25	0.44
Experience: 16 to 20 years	0.18	0.39
Experience: 21 to 25 years	0.13	0.34
Experience: 26 to 30 years	0.05	0.22
Experience: 31 to 35 years	0.03	0.18
Experience: 36 to 40 years	0.01	0.09
Experience: 41 plus years	0.00	0.04

Source: SACMEQ III (SACMEQ, 2007).

3. Hierarchical linear modelling: The necessity of the method

Social science contains countless examples of hierarchical data structures. This means that although variables capture characteristics of individuals, these individuals also exist within

[31] A-levels is not available in the South African education system. It is likely that teachers misunderstood the question and equated A-levels with having completed matric. The variable is retained for the sake of completeness since 16% of teachers reported having completed A-levels.

larger groups and a set of variables describe the groups (Raudenbush & Bryk, 2002: xix). A classic example of hierarchical data structure is education data. Students are grouped according to the schools they attend, so individual or learner-level variables describe individual students, and school-level variables describe schools. Although school-level variables may be independent of the students (for example, the type of buildings or the geographical location of the school), school-level variables may also represent aggregated learner-level data (for example, the racial or gender composition of the school or the average socioeconomic status of the students attending the school). The school probably consists of smaller groups such as classrooms, which have their own characteristics captured by classroom-level variables. Schools may also form the smaller groups contained in school districts (Raudenbush & Bryk, 2002: xix).

In this chapter we are interested in understanding how teacher characteristics influence student performance. As described above, students are grouped within classrooms which in turn are grouped within schools. In education the context in which students are educated is immensely influential in determining their performance. In other words, characteristics of the school classroom significantly influence the level of learning that takes place for individual students and therefore their performance on standardised tests (Luke, 2004: 1). Relationships and occurrences at the higher level of analysis affect what happens at the lower level of analysis. In South Africa the context in which learning takes place differs dramatically across the school system and so the variables describing characteristics at the classroom and school level reflect large differences between schools within the country. We are interested in how these differences at the higher level impact on lower level performance (Luke, 2004: 4-5). For example, how do differences in school management characteristics translate into differences in the performance of students on standardised mathematics and language tests? How does teacher training impact on student performance in mathematics and language tests?

The strongest motivation for making use of hierarchical linear modelling has to do with inaccuracies in the measurement of standard errors. If multi-level data are analysed solely at the level of the individual, two problems arise. The first of these is that the individual error term contains all the contextual information that has not been modelled (Duncan, Jones & Moon, 1998: 98). One of the basic assumptions of multiple regression is that there is no correlation between the error terms of individual observations – an assumption which is violated if individuals (students) share the same context (classroom or school) and the characteristics of this context are not modelled (Luke, 2004: 7). Students who attend the same school or who are taught in the same classroom will probably be more similar to one another than if they were selected at random. Secondly, if the context in which individuals find themselves is not explicitly acknowledged and modelled, regression coefficients is assumed to be equally relevant for all contexts (Duncan et al., 1998: 98). This would indicate that variables affect one another in the same way in all schools in the South African education system, for example – a notion that we know to be false.

How then does estimation in HLM differ from that in OLS? Furthermore, do the estimates and standard errors obtained using OLS and HLM differ substantially enough to warrant the use of HLM over OLS? It may be argued that making use of fixed effects in OLS circumvents the need for HLM. Chaplin (2008: 7) explains that fixed effects models in OLS are models in which the covariance between the error term and some of the explanatory variables is not constrained to be 0. Fixed effects may then control for the effects of characteristics not captured by explanatory variables (i.e. unobserved effects). Using fixed effects in OLS modelling would therefore allow the researcher to claim that the relationship of interest was not biased by unobservable characteristics in the data. For example, in order to observe the relationship between SES and student performance at an individual level and to be sure that the result obtained was not biased by unobservable characteristics at the level of the school, a fixed effects model would include individual school dummies to control for the impact of unobservable characteristics at the level of the school. Fixed effects do not, however, control for the strong possibility that students within a particular school are more similar to one another than students who have been randomly selected.

HLM is therefore often suggested as a safeguard against school effects biasing results obtained for individual level effects. However, this is only the case if multilevel models are actually modelled in the way in which they are presented: as multi-stage models (Chaplin, 2008: 8). Estimating HLM in this way would require first running the individual level model for each school individually, followed by an estimation of second stage equations to investigate the impact of school-level factors on the relationship between individual-level characteristics. This two-stage estimation strategy would allow researchers to claim legitimately that their estimation of the relationship between individual level characteristics is not biased by school level factors (Chaplin, 2008: 8). However, HLM is not estimated in two stages. Coefficients are estimated using both within- and between-school variation and so any omitted variables at the level of the school will bias estimates of the relationship between variables at the level of the individual. HLM assumes zero covariance between explanatory variables and error terms, while OLS estimation using fixed effects allows for non-zero covariance. HLM estimates may therefore be biased (Chaplin, 2008: 8).

One possible way in which to avoid this bias is by centring second level variables (Raudenbush and Bryk, 2002: 23). Centring variables allows the researcher to investigate how the dependent variable responds when the value of explanatory variables change. By centring variables, the researcher is able to see what a standard deviation change in the explanatory variable does to the dependent variable. Centring involves subtracting the group mean (the average value within the group) from the individual values of the variable in order to capture the variation while getting rid of the "group effect". Goldberger (1991: 42) points out that group centring is one way in which fixed effects modelling is conducted in OLS. Chaplin (2008: 9) explains that the HLM estimates arrived at when group-mean centring is used are unbiased. Therefore, despite the fact that HLM controls for the possibility that students selected from the same school are more similar to one another than would be the case had they been selected at random, the fact that HLM models are not estimated in two stages means that variables must first be centred in order to ensure that the estimates obtained using HLM are unbiased.

A question often asked when considering whether to use HLM is whether similar results may not be achieved in OLS by making use of interaction effects. Newman, Newman and Salzman (2010: 5) point out that interaction terms are usually used to investigate the effect within a certain group of a given variable already included in the model over and above the main effect of that variable on the outcome of interest. That is, interaction effects are used to ascertain whether the effect of a particular variable on the outcome variable in one group differs significantly from its overall effect in the entire sample. They explain this as the "differential effect" across groups. HLM investigates the differential effects across groups. The second level of an HLM model therefore provides insights into differences between groups (slope differentials, for example). Interaction terms provide information on the differences over and above the main effect of the explanatory variable in question. Including interaction terms in an OLS model is therefore not the same as explicitly modelling multiple levels of data – the overall objective of HLM.

In summary then, estimates obtained using HLM are only unbiased if variables are. Furthermore, fixed effects estimation in OLS, while remedying the problem of biased estimates resulting from unobservable characteristics at the level of the school, do not control for the likelihood that students attending the same school are more similar than students selected at random. Finally, estimates produced using interaction terms in OLS are different from those obtained using HLM, as interaction effects capture "altered" effects within groups. In the case of HLM, different estimates are obtained for each group. Estimates obtained using HLM and OLS are likely to be similar, however. The estimates presented in this chapter were obtained using HLM, given that it appears to control for more of the complications associated with modelling multilevel data. However, as a robustness check and for the sake of completeness, models were estimated by using OLS and controlling for cluster effects at the level of the classroom. These estimates are presented in Appendix C. The results are similar in size and significance to those obtained using HLM.

3.1 Hierarchical linear modelling: The analytical method

Hierarchical linear modelling is a method that effectively runs regressions of regressions. As explained above, multilevel modelling aims to predict outcomes based on variables from multiple levels (Luke, 2004: 9). In this chapter we investigate student performance in mathematics as a function of both student characteristics (e.g. age, gender, socioeconomic status) and characteristics of teachers (e.g. levels of educational attainment, experience, age). Students are therefore nested within classes[32]. The structure of the model is presented in equations 1 and 2 below.

$$Level\ 1: \quad Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_{ij} \qquad \textbf{(1a)}$$

$$Level\ 2: \quad \beta_{0j} = \gamma_{00} + \gamma_{01} W_j + u_{0j} \qquad \textbf{(1b)}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} W_j + u_{1j} \qquad \textbf{(1c)}$$

The subscript *j* in the equation for level 1 indicates that the model is being estimated *j* times, once for each of the *j* groups in the sample (Luke, 2004: 10). It is therefore possible (and indeed likely) that each of the *j* groups will have a different mean mathematics score (β_{0j}) and that the effects of individual level characteristics (for example, student socioeconomic status) on the outcome variable (β_{1j}) will differ for students taught by different teachers.

In equation 1 the intercept (β_{0j}) and slope (β_{1j}) as outcomes in the group model is straightforward. In equation 1b, the value of β_0 for group *j* is a function of the overall mean for

[32] Students are organised into classrooms, each of which is taught by a particular teacher. For the sake of this analysis, within-classroom differences in fact refer to within-teacher differences. The remainder of the paper will refer to within-classroom elements for the sake of brevity.

the sample (γ_{00}) and the effect of the group-level characteristic W_j on the group average (γ_{01}). The additional variability in the average of group j is captured in the error term u_{0j}. Similarly, the value of $\beta_1$in group j is modelled as a function of the overall mean impact of individual level characteristic (X_{ij}) on student outcomes (γ_{10}) and the effect of the group-level characteristic W_j on this relationship (γ_{11}). The variability in this relationship not accounted for in the model is captured by the error term u_{1j} (Luke, 2004: 10).

Equation 2 condenses the system of equations presented above into one prediction equation.

$$Y_{ij} = \left[\gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}W_j + \gamma_{11}W_jX_{ij}\right] + \left[u_{0j} + u_{ij}X_{ij} + r_{ij}\right] \qquad \textbf{(2)}$$

Equation 2 indicates that the level 1 parameters (β_{0j} and β_{1j}) are estimated indirectly through level 2, and the effects are given by the γs (Luke, 2004: 11). Equation 2 also indicates how the model is broken into fixed effects (the first set of brackets) and random effects (the second set of brackets). The random effects in multi-level modelling can be thought of as the variability that remains after level 1 and level 2 characteristics have been controlled for. This variation is comprised of classic individual level error (r_{ij}) as well as two error terms resulting specifically from the multi-level nature of the model. The first of these, u_{0j}, captures differences in the mean outcome between level 2 groups, and the second of these, u_{1j}, captures differences in the relationship coefficient between the level 1 characteristic and the outcome between level 2 groups (Luke, 2004: 11).

3.2 Means-as-outcome regression

For the purpose of this thesis, the hierarchical linear model that will be used is one which models the intercept term, or the average mathematics performance of students as a function of teacher characteristics. As mentioned before, this chapter aims to investigate the impact of teacher characteristics on student performance. Mean student performance within a school is therefore modelled at the second level. Relationships between student-level characteristics and the outcome variable will not be modelled as being functions of teacher-level characteristics. In terms of the model format presented in equation 1 above, then, the second level of the model is organised as shown in equations 3a to 3d below.

$$\beta_{0j} = \gamma_{00} + \gamma_{01}W_{1j} + \gamma_{02}W_{2j} + \ldots + \gamma_{0S}W_{Sj} + u_{0j} \qquad \textbf{(3a)}$$

$$\beta_{1j} = \gamma_{10} \qquad \textbf{(3b)}$$

$$\beta_{2j} = \gamma_{20} \quad \textbf{(3c)}$$

. .

. .

. .

$$\beta_{Qj} = \gamma_{Q0} \quad \textbf{(3d)}$$

Where S = [1, 2, . . . , S] denotes the number of teacher-level characteristics included in the second level of the model. The combined model therefore takes the form of equation 4.

$$Y_{ij} = \gamma_{00} + \gamma_{10} + \gamma_{20} + \ldots + \gamma_{Q0} + \gamma_{01}W_{1j} + \gamma_{02}W_{2j} + \ldots + \gamma_{0S}W_{Sj} + u_{0j} \quad \textbf{(4)}$$

Where Q = [1, 2, . . . , Q] is the number of student level characteristics controlled for in the first level of the model.

4. Modelling the impact of teacher characteristics on student performance

Contextualising the research conducted in this paper in the model explained above requires first that we present the student-level or "within-classroom" model. This is the level 1 model explained in equation 1 above. This is presented in equation 5 below. Table 1 contains a description of the variables included in this equation.

$$\text{ZMAT}_{ij} = \beta_{0j} + \beta_{1j}(SES) + \beta_{2j}(Overage) + \beta_{3j}(Female) + \beta_{4j}(Mother\ matric) + \beta_{5j}(Father\ matric) + \beta_{6j}(Preschool\ less\ than\ 1) + \beta_{7j}(Preschool\ 1\ year) + \beta_{8j}(Preschool\ 2\ years) + \beta_{9j}(Preschool\ 3\ years\ plus) + \beta_{10j}(English\ sometimes) + \beta_{11j}(English\ most\ of\ the\ time) + \beta_{12j}(English\ always) + \beta_{13j}(Repeated\ once) + \beta_{14j}(Repeated\ twice) + \beta_{15j}(Repeated\ three\ times) + \beta_{16j}(Repeated\ grade\ 6) + \beta_{17j}(Extra\ tuition) + r_{ij} \quad \textbf{(5)}$$

Education production function theory suggests that student education outcomes are a function of both school-level (or "policy-controlled") characteristics and family- and peer-level (or "non-controlled") characteristics (Hanushek, 2007: 3). Family characteristics largely refer to socio-demographic characteristics and in equation 5 include socioeconomic status (*SES*), *Overage*, *Female*, *Mother matric* and *Father matric*. The relationship between SES and student performance is well-documented, particularly in the case of South Africa (Van der Berg et al., 2011). *SES* is included as a student-level explanatory variable to control for this relationship and to ensure that estimates observed for other explanatory variables – many of which are correlated with socioeconomic status – reflect the impact of those variables independently of the impact of SES. *Overage* and *Female* control for the possibility that children who are older than their appropriate age for their grade perform differently to those who are either the correct age for grade 6 or younger, and for the possibility that girls and boys perform differently. Students older than the grade-appropriate age seem likely to perform at a lower level than their peers given the possibility that they have repeated grades. However, dummy variables controlling for whether students have repeated a grade once, twice or three times and whether they are repeating their current grade (grade 6) are included to control for this possibility. As the results in section 6 indicate, the effect of being overage appears to work separately from the effect of repetition. Parental education is often included in the SES term in education production functions. The SES term in the SACMEQ III data was created using questions about assets in students' homes and did not include information on parental education. Parental education is an important socio-demographic indicator and whether or not a student's mother and father have attained matric are entered separately to investigate whether or not they have separate effects on student performance. As pointed out in section 2, testing in SACMEQ III in South Africa was conducted in English and Afrikaans. For the majority of South African students, neither of these is a first or home language. The frequency with which students speak English controls to some extent for this (*English sometimes*, *English most of the time*, *English always*), but the same variable does not exist for Afrikaans. *Extra tuition* controls for students receiving extra tuition but may well capture students with lower levels of ability rather than the effect of receiving instruction additional to that which they receive in the classroom. The number of years of preschool education is captured by four variables (*Preschool – less than 1 year, Preschool – 1 year, Preschool – 2 years and Preschool – 3 years plus*) in order to investigate whether investment in "school-readiness" has a significant impact on student performance.

The study investigates whether β_{0j} differs across teachers. The combined model of characteristics of both students and teachers is presented in equation 6.

$$\text{ZMAT}_{\text{ij}} = \gamma_{00} + \gamma_{01}(Teacher\ is\ female) + \gamma_{02}(30\ to\ 39\ years\ old) +$$
$$\gamma_{03}(40\ to\ 49\ years\ old) + \gamma_{04}(50\ to\ 59\ years\ old) + \gamma_{05}(60\ to\ 69\ years\ old) +$$
$$\gamma_{06}(Teacher\ maths\ score) + \gamma_{07}(Experience) + \gamma_{08}(Days\ of\ training)\ +$$

$$\gamma_{09}(Trained\ in\ mathematics) + \gamma_{010}(Trained\ to\ teach\ maths) + \gamma_{011}(Junior\ secondary\ education) + \gamma_{012}(Senior\ secondary\ education) + \gamma_{013}(A\ levels) + \gamma_{014}(Degree) + \gamma_{015}(Less\ than\ 1\ year\ teacher\ training) + \gamma_{016}(1\ year\ of\ teacher\ training) + \gamma_{017}(2\ years\ of\ teacher\ training) + \gamma_{018}(3\ years\ of\ teacher\ training) + \gamma_{019}(more\ than\ 3\ years\ of\ teacher\ training) + \gamma_{020}(Parents\ sign\ homework) + \gamma_{021}(Test\ 2\ or\ 3\ times\ per\ terms) + \gamma_{022}(Test\ 2\ or\ 3\ times\ per\ month) + \gamma_{023}(Test\ at\ least\ weekly) + \gamma_{024}(Average\ class\ size) + \gamma_{025}(Rural) + \gamma_{026}(Average\ classroom\ SES) + \gamma_{027}(Private) + \beta_{1j}(SES) + \beta_{2j}(Overage) + \beta_{3j}(Female) + \beta_{4j}(Mother\ matric) + \beta_{5j}(Preschool\ less\ than\ 1) + \beta_{6j}(Preschool\ 1\ year) + \beta_{7j}(Preschool\ 2\ years) + \beta_{8j}(Preschool\ 3\ years\ plus) + \beta_{9j}(English\ sometimes) + \beta_{10j}(English\ most\ of\ the\ time) + \beta_{11j}(English\ always) + \beta_{12j}(Repeated\ once) + \beta_{13j}(Repeated\ twice) + \beta_{14j}(Repeated\ three\ times) + \beta_{15j}(Repeated\ grade\ 6) + \beta_{16j}(Extra\ tuition) + r_{ij} + u_{0j} \quad \textbf{(6)}$$

The research question is whether or not teacher characteristics impact significantly on student performance. The variables at the teacher level in equation 6 are grouped according to four categories: demographic characteristics, education and experience characteristics, effort characteristics and school/classroom characteristics.

Demographic characteristics: Teacher gender may be important in explaining student performance if male and female teachers differ significantly from each other in terms of their ability to teach. *Teacher female* is included to control for whether a teacher is female and whether this has a statistically significant effect on mean student mathematics performance. Teacher age is controlled for using dummy variables for 10 year bands and the impact of teachers' age is measured relative to the youngest group of teachers (19 to 29 year olds). Significant coefficients on these variables may indicate either inherent differences in the ability of teachers to improve student performance associated with teacher age, or potentially differences in the training received by teachers trained at different times in South Africa.

Education and experience: *Experience*[33] is included to capture the number of years that teachers have been teaching. Literature on teacher experience suggests that beyond the initial

[33] Teaching experience and teacher age may have conflating effects on student performance. However, the model was run without controlling for teaching experience and this made very little difference to the age coefficients.

years of teacher experience, the impact of having taught for longer periods of time becomes smaller. Teaching experience is rarely found to be statistically significant in its impact on student performance (Koedel, 2007). It is included in this analysis as dummy variables capturing experience in 5 year bands. Dummy variables capturing teachers' level of educational attainment are included to ascertain whether a certain level of education impact student performance significantly. Given the restructuring of teacher training with the closing of teacher training colleges in 2000, it is important to investigate the extent to which the attainment of a university degree impacts on student performance.

Days of training captures the time teachers spent participating in in-service training courses. In-service training programmes are perceived by researchers to be largely ineffective in affecting student performance (NEEDU, 2013: 15).

Teacher training is captured by dummy variables reflecting whether teachers received less than 1 year, 1 year, 2 years or 3 years of teacher training. In the South African education system, teachers may qualify via various channels, an explanation of which is included in Appendix D. It is important to investigate the extent to which different avenues to teacher training impact on student performance.

Teacher maths score[34] is included to control for teachers' own mathematical content knowledge. The model is run including teacher maths score as well as excluding it. This is done in order to ensure that the impact of teacher training variables is separated from teachers' own performance in mathematics. Finally, dummy variables controlling for whether teachers are trained to teach (i.e. pedagogical training) and whether they are trained specifically to teach maths are included.

Effort characteristics*: Parents sign homework* is included as a dummy variable to capture the extent to which teachers ensure that students complete their assigned work. The variable is intended to proxy for teachers' interest in students' progress. Dummy variables controlling for the frequency of testing are included to measure teacher "engagement" with students' progress. Marking of tests is time-consuming and often tedious work for teachers. It is assumed that higher frequencies of testing indicate higher levels of effort. Important to note is that both

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Experience and age were asked separately in the teacher questionnaire. Both have been retained as they control for different characteristics, and both are necessary for the sake of this analysis.

[34] Teacher maths score is missing for 98 teachers in the SACMEQ III dataset. Where possible, missing data were replaced with the mean mathematics score of teachers within the same school. Teachers from schools in which no teachers wrote the mathematics tests were excluded from the model in which teacher maths score was included as an explanatory variables. This meant that 29 teachers were dropped from this sample.

variables are self-reported by teachers. It is likely therefore that the extent to which these activities occur is over-stated.

School and classroom characteristics: A number of variables included in the teacher-level model are in fact school-level characteristics, but in the case of the SACMEQ data in a significant number of schools only one classroom was sampled. The classroom is therefore completely identified by the school and so for these variables (with the exception of *Classroom SES)* no variation occurs at the level of the school. The school-level variables, namely *Rural, Private school* and *Average class size* are therefore included to control for differences that are observed between students attending schools with these characteristics and those attending schools in which these characteristics are absent.

5. Results

The multi-level nature of education data necessitates hierarchical or multi-level modelling. The overall variation in student performance can be at the level of the student and the teacher. In other words, there are characteristics of both students and their teachers that influence student performance. A first step in performing hierarchical linear modelling is to ascertain whether or not any variation occurs at the higher level. The extent to which student performance is attributable to teacher characteristics therefore needs to be tested.

Formally partitioning the variance into the components that occur at the level of the student and the teacher is achieved by running a fully unconditional model in which students' mathematics performance is allowed to vary without including controls for any level 1 (student) or level 2 (teacher) characteristics. This is presented in equation 7 below.

$$Y_{\boldsymbol{ij}} = \beta_{0j} + r_{ij}$$

where $$\beta_{0j} = \gamma_{00} + u_{ij} \qquad \textbf{(7)}$$

The variance component associated with level 1 (i.e. the student level), r_{ij} (σ^2), is estimated at 0.452, while that associated with level 2 (i.e. the level of the teacher), $u_{ij}(\tau_{00})$, is estimated at 0.747. The intra-class correlation coefficient (ICC) is the variance at the level of the teacher as a proportion of overall variance. The ICC (ρ) is therefore calculated according to equation 8.

$$\rho = \frac{\tau_{00}}{\sigma^2+\tau_{00}} = \frac{0.738}{0.451+0.738} = 0.621 \qquad \textbf{(8)}$$

The variances presented above result in ρ = 0.621, indicating that just over 62% of the variation in students' mathematics performance is explained at the level of the teacher or school. There therefore seems to be a case for using multi-level modelling to explain the factors influencing student performance. The reliability estimate of the intercept term,[35] which measures the ratio of the variance of the parameter estimate to that of the sample mean for the intercept term, is 0.957, indicating that a large proportion of the variance in mean mathematics performance across teachers may potentially be explained at the level of the teacher.

This analysis of variance is conducted without including controls at either level. This may be problematic for two reasons. Firstly, it is possible that group-level predictors impact substantially on the outcome variable but that two variables have opposite effects with the result that they cancel each other out (Chaplin, 2008: 11). In this case, it may appear that no variation occurs at the level of the group when in fact group-level characteristics are significant in determining the outcome. Secondly, individual and group-level characteristics may offset each other, again masking sources of variation in the outcome variable and making it seem as if multi-level modelling is unnecessary when in fact significant variation occurs at the level of the group (Chaplin, 2008: 12). In both cases then the danger is that group-level variation is being masked. As shown below, it is unlikely that this is a problem in South Africa given the large proportion of variation in student mathematics explained at the level of the classroom.

The within-classroom model is presented in table 6 below.

TABLE 6: Student-level model

	Estimated Fixed Effects	
	Coefficients	**Standard Errors**
Intercept	0.105***	0.036
Student SES	0.132***	0.015
Overage	-0.130***	0.025
Female	-0.004	0.018
Mother completed matric	0.099***	0.020
Father completed matric	0.051***	0.049
Less than 1 year preschool	0.015	0.042
1 year of preschool	0.036	0.024
2 years of preschool	0.060**	0.028
3 or more years of preschool	0.109***	0.029

[35] The reliability estimate is calculated as $\lambda_j = \frac{\tau_{00}}{\tau_{00}+\frac{\sigma^2}{n}}$

Speaks English sometimes	0.166***	0.026
Speaks English most of the time	0.188***	0.042
Speaks English always	0.310***	0.059
Repeated a grade once	-0.215***	0.027
Repeated a grade twice	-0.210***	0.039
Repeated a grade three times	-0.250***	0.050
Repeated grade 6	-0.033	0.032
Receives extra tuition	-0.159***	0.044

Estimated Random Effects			
	Standard Deviation	**Variance**	**Chi-Squared**
Intercept	0.685	0.469	7711.760
Within-classroom	0.653	0.426	
Reliability of teacher-level random effects			
	Mean score	0.937	

Source: Own calculations from SACMEQ III (SACMEQ, 2007).

The results presented in table 6 above indicate that, predictably, socioeconomic status has a positive and significant impact on student mathematics performance. The coefficient in the table indicates that if student socioeconomic status increased by 1 standard deviation and the values of all other variables were held constant, student mathematics performance would improve by 0.130 standard deviations. Overage students perform 0.130 below their peers who are not overage (i.e. who are either the correct age for their grade or younger than the correct age for their grade) while students whose mothers completed matric outperform those whose mothers did not by 0.099 standard deviations. The impact of fathers having completed matric is positive and significant, but smaller than that observed for mothers at 0.051. This is in line with what is observed internationally. Students who have received 1, 2 and 3 years of preschooling outperform those who have had no preschooling by 0.035, 0.060 and 0.109 standard deviations respectively, while students who speak English outside the classroom sometimes, often and always outperform those who do not speak English outside the classroom by 0.166, 0.188 and 0.309 standard deviations respectively. Students who have repeated a grade once, twice or three times perform 0.22, 0.21 and 0.25 standard deviations below students who have not repeated a grade, respectively, indicating that there is no real difference in the performance amongst students who have repeated grades.[36] The coefficient for students repeating grade 6 is not statistically significantly different from that of students who are not

[36] An F-test confirms this.

repeating grade 6, suggesting that students repeating grade 6 do not perform differently from students repeating other grades[37]. Students receiving extra tuition are outperformed by their peers not receiving extra tuition by 0.159 standard deviations. This may well reflect a lower ability in the students receiving extra tuition rather than the extra tuition having a negative impact on their performance.

Controlling for the student level characteristics decreases the within-classroom variance by roughly 37% from 0.747 to 0.469. The fact that level 1 characteristics explain so little of the variance of the mean highlight the fact that a substantial portion of the variation in student performance is explained at a higher level or not at all. Most educational performance data for South Africa contain neither pre-test scores nor racial classification – both of which are highly correlated with educational performance. This is obvious in the case of pre-test scores. In the case of race, performance in the South African education system is still significantly correlated with performance of the system under apartheid, with the part of the schooling system historically serving South Africa's white population far outperforming the part of the schooling system historically serving South Africa's black population. The historically white part of the schooling system is now substantially more representative of South Africa's population than in previous years, while the historically black portion remains almost entirely black. Most white children find themselves in the historically white part of the schooling system and for this reason race is a significant determinant of schooling performance.

In addition, the variables included in the within-classroom model control for the home background and variables pertaining to previous education performance. Unobservable characteristics such as intelligence or ambition play a significant role in school performance. However, it is impossible to measure and control for them.

In order to investigate the extent to which teacher-level characteristics impact on student performance, level 2 variables are added to the model. Table 7 below presents the results from the full multilevel model. Model 1 contains the results for the full teacher model including teacher maths score, while model 2 excludes teacher maths score.

[37] An F-test confirms this.

TABLE 7: Full hierarchical linear model

Variable	Model 1		Model 2	
	Coefficient	**Std deviation**	**Coefficient**	**Std deviation**
Intercept	0.231	0.208	0.278	0.286
TEACHER DEMOGRAPHIC CHARACTERISTICS				
Female	0.071	0.046	0.063	0.045
30 to 39 years of age	-0.345***	0.130	-0.378***	0.131
40 to 49 years of age	-0.389***	0.132	-0.474***	0.132
50 to 59 years of age	-0.522***	0.160	-0.618***	0.161
60 years and older	-0.325***	0.296	-0.360*	0.301
TEACHER EDUCATION AND EXPERIENCE				
Teacher maths score	0.105***	0.024		
Experience: 6 to 10 years	0.150*	0.084	0.181**	0.084
Experience: 11 to 15 years	0.031	0.064	0.086	0.062
Experience: 16 to 20 years	-0.033	0.077	-0.022	0.075
Experience: 21 to 25 years	-0.027	0.083	-0.038	0.083
Experience: 26 to 30 years	0.170	0.141	0.226	0.138
Experience: 31 to 35 years	0.267*	0.162	0.323**	0.164
Experience: 36 to 40 years	0.042	0.266	0.071	0.270
Experience: 41 plus years	-0.412	0.624	-0.434	0.637
Number of days training received	-0.000	0.001	0.000	0.00
Trained in mathematics	0.093	0.303	0.086	0.308
Trained to teach mathematics	-0.213	0.302	-0.184	0.306
Completed jr secondary education	-0.029	0.164	0.006	0.166
Completed sr secondary education	0.058	0.086	0.064	0.087
Completed A-levels	0.002	0.072	0.033	0.071
Completed a degree	0.097*	0.059	0.111*	0.058
Received less than 1 year training	0.923	0.644	0.579	0.453
Received 1 year of training	0.029	0.306	0.011	0.308
Received 2 years of training	0.254	0.293	0.191	0.297
Received 3 years of training	0.169	0.280	0.112	0.284
Received 3 years plus of training	0.215	0.281	0.180	0.285
TEACHER EFFORT				
Parents sign students' homework	0.032	0.048	0.023	0.048
Test 2 to 3 times per term	0.020	0.075	0.034	0.076
Tests 2 to 3 times per month	0.025	0.080	0.015	0.081
Tests at least once per week	0.088	0.087	0.082	0.088
SCHOOL AND CLASSROOM CHARACTERISTICS				

Rural	-0.007	0.055	-0.001	0.054
Classroom SES	0.568***	0.040	0.683***	0.036
Private school	0.002	0.107	-0.024	0.108
Average class size (of the school)	-0.006***	0.002	-0.006***	0.002
STUDENT CHARACTERISTICS				
SES	0.063***	0.013	0.062***	0.012
Overage	-0.096***	0.022	-0.101***	0.021
Female	-0.007	0.015	-0.003	0.014
Mother completed matric	0.074***	0.017	0.072***	0.017
Father completed matric	0.048***	0.017	0.045***	0.017
Less than 1 year preschool	0.018	0.037	0.024	0.03
1 year of preschool	0.033	0.020	0.026	0.020
2 years of preschool	0.035	0.025	0.040	0.025
3 or more years of preschool	0.093***	0.024	0.094***	0.024
Speaks English sometimes	0.157***	0.020	0.157***	0.020
Speaks English most of the time	0.160***	0.034	0.158***	0.032
Speaks English always	0.271***	0.039	0.249***	0.038
Repeated a grade once	-0.204***	0.022	-0.206***	0.021
Repeated a grade twice	-0.229***	0.038	-0.211***	0.036
Repeated a grade three times	-0.249***	0.050	-0.218***	0.046
Repeated grade 6	-0.043	0.032	-0.052*	0.030
Receives extra tuition	-0.147***	0.034	-0.137***	0.032

Estimated Random Effects

	Standard Deviation	Variance	Chi-Squared
Intercept	0.416	0.173	3 468.531
Within-classroom	0.651	0.424	

Reliability of teacher-level random effects

Mean score	0.852	

Source: Own calculations from SACMEQ III (SACMEQ, 2007).

The results obtained from the full model are discussed for the model excluding teacher mathematics score as this model is run for a greater number of observations. The results obtained for both specifications are largely similar, however. Coefficients which differ markedly from each other will be discussed where relevant. For the most part, however, they are largely similar.

Teacher demographic characteristics*:* Whether a teacher is female does not have a statistically significant impact on student performance. An interesting result obtained is the effect of teacher age on mean student performance. The coefficients on age indicate that relative to the reference group (teacher age 19 to 29 years old – the youngest group of teachers in the sample), the mean mathematics score of students taught by teachers from all other age groups is lower. Furthermore, with the exception of the coefficients on SES and less than 1 year of teacher training, the coefficients on teacher age groups are the largest amongst the teacher level characteristics. Indeed the mean mathematics score of students taught by teachers who are 30 to 39 years old, 40 to 49 years old, 50 to 59 years old and older than 60 are respectively 0.378, 0.474, 0.618 and 0.360 standard deviations below that of students taught by teachers belonging to the youngest age group.[38] The size of the coefficient for the group of teachers aged 50 to 59 years old is slightly higher than for the other age groups, but other than this coefficients for different age groups seem consistent.[39] This may say something about teacher training, given the movement away from teacher training colleges in 2000. This is discussed in greater depth later.

***Teacher education and experience**:* Some interesting results are observed for variables capturing teacher qualifications. The mean performance of students being taught by teachers who have obtained a university degree is 0.111 standard deviations higher than that of students taught by a teacher who has not obtained a university degree. Important to acknowledge at this stage is that the positive association between teachers having a university degree and student performance is likely driven to some extent by the fact that better educated teachers are able to secure employment in well-performing schools. This selection effect means it is likely that variables controlling for SES – a key predictor of school performance – do not capture all aspects of schools' socioeconomic context.

In terms of teaching experience, coefficients for two of the dummy variables are statistically significant – *Experience 6 to 10 years* and *Experience 31 to 35 years*. The coefficients on these variables indicate that relative to students being taught by teachers with 5 or less years of teaching experience, students being taught by a teacher with 6 to 10 years of teaching

[38] A possible explanation for the difference in the ability of younger teachers to elicit superior performance from their students is the fact that they themselves have a better grasp of the mathematical content which they are required to teach. An important part of understanding the differences illustrated by the coefficients above is investigating whether younger teachers are better at maths or whether they are better teachers. This is tested by interacting teacher test score with the dummy variables controlling for age. However, the coefficients are small and statistically insignificant. It does not appear therefore that this effect works through superior mathematical content knowledge amongst younger teachers.

[39] The model was re-run with different cohorts of teachers as the reference group. The results indicate that although the differences in the coefficients are smaller in size amongst groups older than the youngest group, the ability to elicit stronger performance from students does differ by teacher age, with younger teachers out-performing their older colleagues. This is confirmed by an F-test.

experience perform on average 0.181 standard deviations better, and students being taught by teachers with between 31 and 35 years of teaching experience perform 0.323 standard deviations above other students. Interestingly, in model 1 (which controls for teachers' performance on their mathematics tests), teachers' mathematics test performance results are statistically significantly positively related to mean student mathematics performance. As teachers' maths scores are z-scored, the coefficient of 0.105 indicates that an improvement of 1 standard deviation in teacher maths performance results in an improvement of 0.105 standard deviations in mean mathematics performance amongst students.

Teacher effort*:* None of the teacher effort variables included in the model appears to impact on mean mathematics performance in a significant way. This may be due to the fact that these variables are self-reported by teachers. The frequency of testing as well as whether parents are required to sign homework may well be over-reported.

School and classroom characteristics: The large and statistically significant coefficient observed for classroom SES is to be expected. The coefficient of 0.627 indicates that a 1 standard deviation increase in classroom SES is associated with a 0.627 standard deviation increase in mean mathematics performance. The statistically significant negative coefficient for *Average class size (of the school)* is intuitive, suggesting that larger classes are associated with weaker performance. The size of the coefficient is very small, however. Increasing class size by one student decreases mean student performance by 0.006 of a standard deviation. Despite the fact that it is statistically significant, it is not economically significant. It is too small to indicate any real relationship between the variables.

6. Discussion and conclusion

The results presented above are important in the context of South Africa's education system. Teachers are an important resource in education and it is necessary to understand how best to utilise the resource.

The results for the hierarchical linear model reveal that younger teachers are better able to increase the mean performance of students. In order to test whether this is a trend observed amongst teachers across different countries or whether this is a trend particular to South Africa, the identical HLM model was run for 3 other countries in the SACMEQ III dataset – two of South Africa's neighbouring countries, Botswana and Zimbabwe, and a high-performing East

African country, Kenya. The coefficients on the teacher age variables are presented in table 8 below.

TABLE 8: HLM coefficients on teacher age variables for 4 SACMEQ countries

Teacher age	Botswana	Kenya	Zimbabwe	South Africa
30 to 39 years old	-0.075	0.062	0.005	-0.378***
	(0.078)	(0.109)	(0.103)	(0.131)
40 to 49 years old	-0.029	-0.232	-0.115	-0.474***
	(0.103)	(0.142)	(0.130)	(0.132)
50 to 59 years old	0.199	-0.561***	-0.287	-0.618***
	(0.152)	(0.191)	(0.201)	(0.161)
60 to 69 years old	-	-	-0.318	-0.360*
			(0.588)	(0.301)
Number of students	3 842	4 272	2 983	8 917
Number of teachers	342	259	273	498

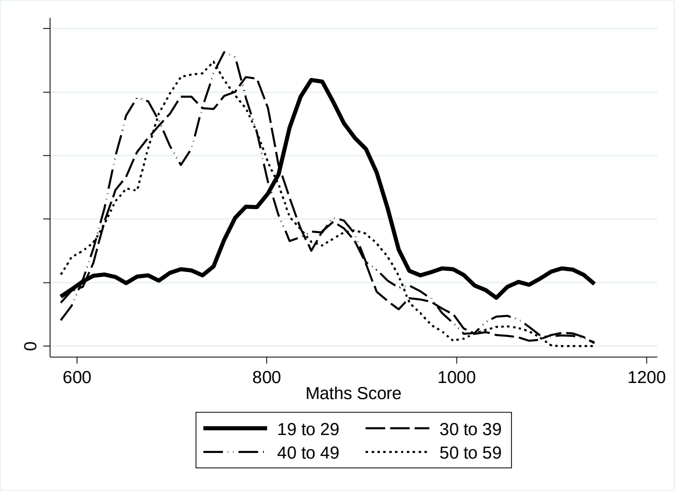
Source: Own calculations from SACMEQ III (SACMEQ, 2007).

The pattern for lower mean mathematics performance amongst students being taught by older teachers appears in Kenya. The magnitude of these coefficients is comparable with those observed in South Africa. In fact in Kenya, the coefficient for teachers aged 50 to 59 years old is almost double that of South Africa's. However, this is the only coefficient which is statistically significant whereas in the case of South Africa, the coefficients for all teacher age groups are statistically significant relative to the reference group of teachers aged 19 to 29 years old.[40]

This discussion investigates why this may be the case. As described earlier, the studies conducted by SACMEQ in 2000 and 2007 included teacher tests. Due to union objections to teachers being tested, South African teachers participated only in the teacher test conducted in 2007 and were allowed to opt out of being tested. Interestingly, teacher performance on the mathematics test appears to differ according to age in the same way that teachers' ability to elicit test performance from their students does. Figure 23 below presents the distribution of teacher performance on mathematics tests for teachers of different ages.

[40] The coefficient for South African teachers aged 60 and older is not statistically significant. However, this group is comprised of just 4 teachers.

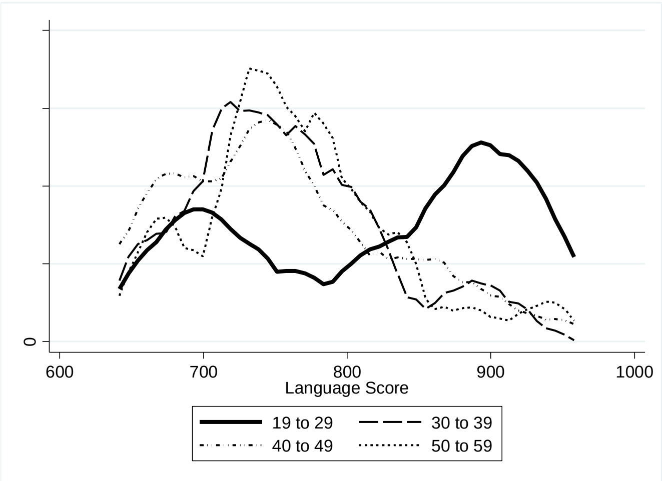
FIGURE 23: Teacher mathematics score by age group



Source: SACMEQIII, 2007.

The kernel density curves drawn in figure 23 demonstrate that younger teachers perform at a significantly higher level in the mathematics test than teachers in older age groups. Similar results are obtained with regards to teacher performance on language tests. Figure 24 presents the distribution of language performance results amongst teachers in different age groups. As seen in the mathematics test, teachers in the age group 19 to 29 perform better than their counterparts in older age groups in the language test.

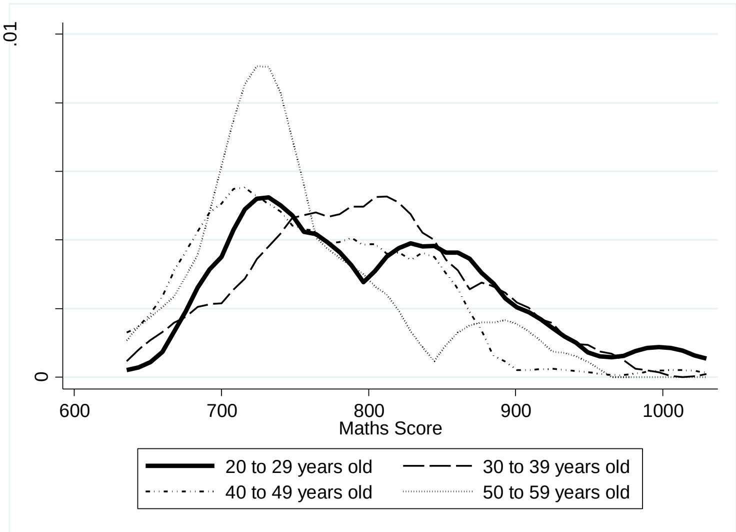
FIGURE 24: Teacher language score by age group



Source: SACMEQIII, 2007.

Kernel densities for Botswana, Kenya and Zimbabwe were drawn for teacher performance in mathematics tests in figures 25, 26 and 27 below and for teacher performance in language tests in figures 28, 29 and 30.

FIGURE 25: Teacher mathematics score by age (Botswana)

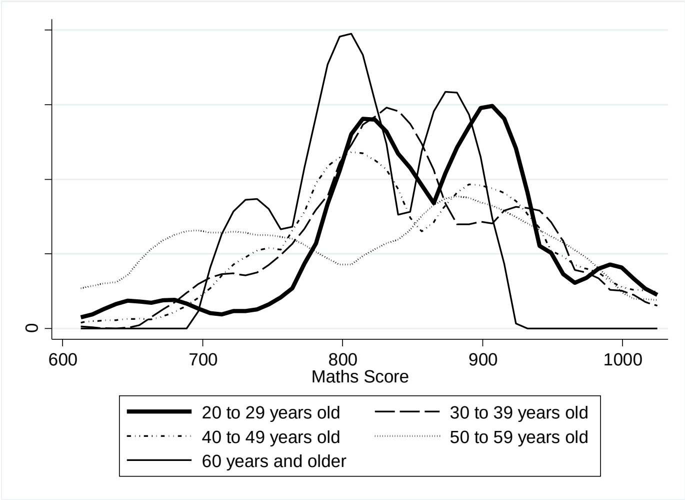


Source: SACMEQIII, 2007

FIGURE 26: Teacher mathematics score by age (Kenya)

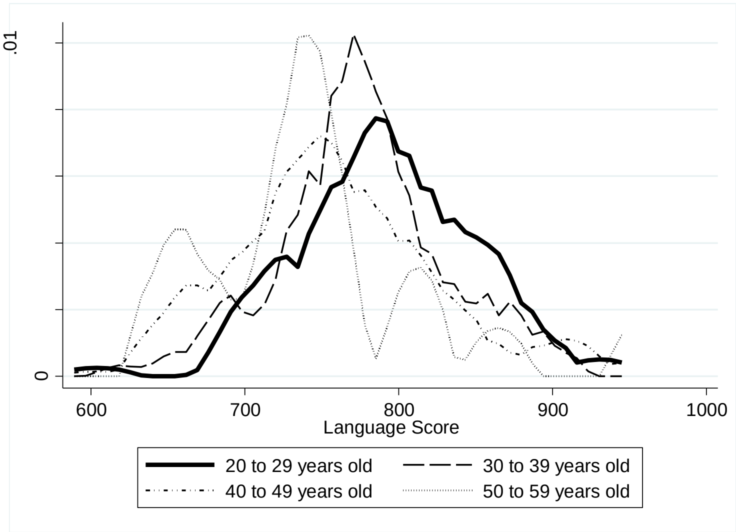
Source: SACMEQIII, 2007

FIGURE 27: Teacher mathematics score by age (Zimbabwe)



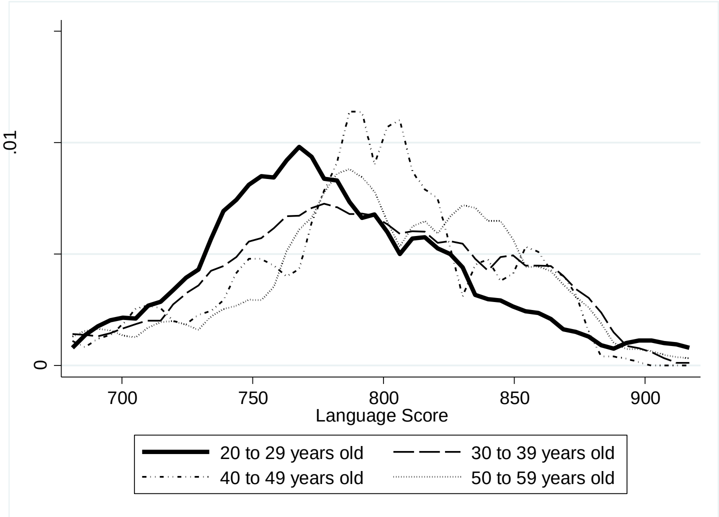
Source: SACMEQIII, 2007

FIGURE 28: Teacher language score by age (Botswana)



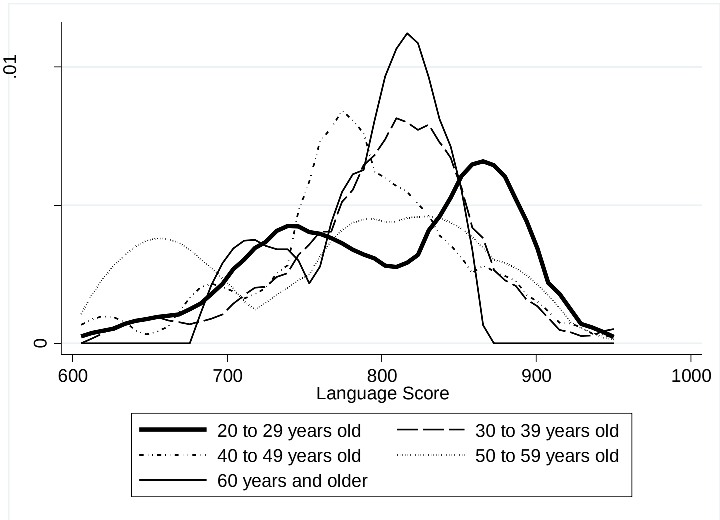
Source: SACMEQIII, 2007

FIGURE 29: Teacher language score by age (Kenya)



Source: SACMEQIII, 2007

FIGURE 30: Teacher language score by age (Zimbabwe)



Source: SACMEQIII, 2007

The differences in the performance of teachers of different ages in Botswana, Kenya and Zimbabwe are not as marked as they are in South Africa. It seems therefore that this is a phenomenon particular to South Africa.

A basic OLS regression was run to investigate whether the difference in performance between teachers is statistically significant. The results are presented in table 9 below.

TABLE 9: Regression of teacher test performance on teacher age

	Coefficient and standard deviation	
Variable	**Mathematics**	**Language**
30 to 39 years old	-0.997*	-0.715***
	(0.555)	(0.269)
40 to 49 years old	-1.586***	-0.701***
	(0.552)	(0.269)
50 to 59 years old	-1.237**	-0.738***
	(0.596)	(0.286)
60 years and older	-1.452	-0.330
	(1.243)	(0.408)
Constant	0.416	0.734***
	(0.530)	(0.256)
Sample size	497	415
R-squared	0.03	0.01

Source: Own calculations from SACMEQ III (SACMEQ, 2007).

It therefore appears that older teachers are outperformed by younger teachers in both mathematics and language. Younger mathematics teachers also seem better able to elicit better performance from their students. It is important to investigate the possible reasons for this pattern. Similar estimates were found by using data from PIRLS 2006 on reading and literacy amongst students of a similar age. Shepherd (2013: 31) used weighted least squares regression to investigate the determinants of student reading and literacy and found a large, positive and statistically significant coefficient for teachers who are 30 years old or younger. Interestingly, this is only observed amongst teachers of students who wrote the PIRLS test in an African language and who were therefore in the historically black part of the schooling system. Amongst students writing the test in English of Afrikaans, the coefficient was somewhat smaller, negative and statistically insignificant (Shepherd, 2013: 31). Interestingly, when the model is run for quintiles 1 to 4 for South Africa in the SACMEQ III dataset, the coefficients diminish in size and although still statistically significant, they are significant at a lower level. The results are presented in Appendix C.

More than one explanation may exist for the differential ability of younger teachers to elicit stronger performance from their students. Younger teachers may relate better to their students because they are closer in age than their older counterparts. Another possibility is that changes to teacher training may have left teachers trained under a new system better equipped to teach. We are able to test these hypotheses using data from the second SACMEQ survey conducted in 2000. As mentioned above, no teacher tests were conducted for South African teachers in 2000. Other than that, the questionnaires were almost identical, making it possible to compare the two surveys and so the same model can be run for SACMEQ II data. If younger teacher are inherently better at teaching (and not as a result of different teacher training) we expect to see similar coefficients to those observed using the SACMEQ III data for teacher age variables in similar models from different time periods.

The full HLM model was run using SACMEQ II data. The full results are presented in Appendix B. Table 10 presents the coefficients on the teacher age variables obtained when data from the 2000 study were used.

TABLE 10: HLM coefficients on teacher age variables using SACMEQ II (2000)

Teacher age	Coefficient (Std. Error)
30 to 39 years old	0.003 (0.120)
40 to 49 years old	0.315* (0.189)
50 years and older	0.671** (0.232)
Number of students	3 135
Number of teachers	187

Source: Own calculations from SACMEQ II (SACMEQ, 2000).

The coefficients in table 10 are quite different from those obtained from the 2007 data of the SACMEQ III survey. In fact, only the teachers aged 50 to 59 differ significantly from the youngest group of teachers and in this case, they seem to elicit better performance from their students. According to this data then, the statistically significant negative coefficients observed for teachers older than the 29 years of age (relative to the youngest group) are not explained by an inherent ability of younger teachers to positively influence mean student performance. It is possible then that differences in teacher training explain the differences in the student performance according to the age of their teacher.

As explained in the next subsection, teacher training is one of the few characteristics that may render younger teachers better able to impact positively on their students' performance. Changes in teacher training in the South African education system occurred in the late 1990s and early 2000s – the time in which the youngest cohort of teachers were trained. The following section discusses these changes.

6.1 Differences in teacher training[41]

An obvious avenue to pursue in understanding the differences that are observed in the performance of teachers of different ages is to investigate the extent to which the training received by teachers differed across years. A potential source of differences in teacher training is the shift from teacher training colleges as the institutions responsible for training teachers to the incorporation of teacher training within universities. Chisholm (2009: 9) explains that teacher training colleges expanded predominantly in the 1960s. The apartheid state located the majority of teacher training colleges in the "homeland" areas with the objective of staffing the colleges with the graduates. Chisholm (2009: 14) explains that enrolment in the teacher colleges was high due to the fact that opportunities in the formal economy were restricted for non-white South Africans, and entering a teacher training college was one of the very few ways in which people living in the homelands could enter higher education.

Teacher training colleges were expensive to run and were heavily subsidised by the state (Chisholm, 2009: 16). Because of a movement towards decreasing unit costs and enhancing productivity within the higher education sector, teacher colleges were offered the option of remaining open as independent institutions if they were able to enrol 2 000 full-time students in 1999, or becoming integrated as part of universities or universities of technology. Teacher training colleges were formally incorporated into universities and universities of technology from January 2001 (Chisholm, 2009: 16). Irving (2012: 389) explains that changes to teacher training in South Africa have been abrupt and dramatic. The closure of teacher colleges and the relocation of teacher training to universities was a considerable change and required adjustment.

Teachers trained after the incorporation of teacher training colleges into universities or universities of technology would therefore have been 25 years old in 2007 when SACMEQ III

[41] A brief explanation of the minimum requirements for the education of teachers is contained in Appendix C.

was conducted[42] and allowing for some violations of the assumptions explained in footnote 1 below, the age group of 19 to 29 years old (the reference group in the analysis conducted above) captures teachers who are likely to have completed their teacher training at universities or universities of technology.[43]

If we assume that teacher training does in fact influence teacher performance, then it appears that teachers trained at universities and universities of technology are better able to teach than are teachers trained at teacher training colleges. If this is the correct interpretation of the results obtained in table 4, it has important implications for the teacher training landscape in South Africa. South African teacher unions have since 2002 called for the reopening of teacher training colleges (Chisholm, 2009: 17). The South African Democratic Teachers Union (SADTU), the biggest union as it represents two thirds of teachers (Wills: 2014: 4), is of the opinion that teacher shortages (particularly in the areas of mother tongue and foundation phase education) result in excessively large class sizes which interfere significantly with the ability of their members to provide quality education. Indeed, at SADTU's 2006 National Conference, there was a recommendation for setting a maximum acceptable class size of 30 students – a number which requires substantial increases in teacher supply in order to be achieved (Chisholm, 2009: 17). This resulted in SADTU's 2007/08 call for the reopening of teacher training colleges.

A second argument in favour of reopening teacher training colleges has to do with the quality of teacher training provided by universities and universities of technology. Patterson and Arends (2008: 85) are of the opinion that primary and secondary school teaching are not given the attention they require in the higher education system. They consider university fees for studying to teach primary education high enough to exclude candidates from the teaching profession. Finally, university education is considered by teachers already teaching in schools to be excessively theoretical and abstract relative to what is required to teach primary school (Patterson and Arends, 2008: 86). Teachers and lecturers trained in teacher training colleges feel that universities and universities of technology lack the "hands on" practical guidance that was provided by colleges. They are of the opinion that principals and experienced teachers do

[42] With the data available there is no way of knowing at what age teachers were trained. The age of 25 is based on the assumptions that teachers started higher education directly after finishing secondary school, and that teachers left secondary school at the grade appropriate age of 18, therefore turning 19 in their first year of tertiary education. In many instances these assumptions are most definitely violated. It is likely for example that individuals took longer than the prescribed amount of time to complete tertiary education, and that individuals started teacher training after having completed other courses of study.

[43] 73% of the teachers in this age group are younger than 25 years old.

not have the same opportunities for involvement in training future teachers as had been available in teacher training colleges (Chisholm, 2009: 17).

For various reasons, therefore, there is a strong belief that re-opening teacher training colleges may improve the quality (and quantity) of teachers in general, and primary teachers in particular. The evidence above suggests that this may not be the case.

6.2 Other sources of differentials by teacher age

Other explanations for differences in the performance of older and younger teachers have less to do with the structures within which teacher training takes place and more with the nature of teaching itself. Anecdotal evidence from teachers suggests that younger teachers are better able to engage and build rapport with their students because they are closer in age to students and because successful teaching requires high levels of energy. Younger teachers are also likely to be more familiar with the current curriculum and may therefore be more familiar with the content they are required to teach to students (Education Forum, 2006). An unflattering view of the performance gap between older and younger teachers is the tendency or willingness of younger teachers to “cheat” or teach to the test in order to appear to be performing well, compared to older teachers who would probably be more intent on ensuring that students receive a broader, more complete education rather than to focus on what is prescribed by the curriculum (Education Forum, 2006). Literature on differences in performance of teachers by age is scarce in the area of primary education. Very little empirical evidence exists of such disparities, which renders the results obtained in this paper quite important.

The most important finding from this chapter then has been that younger teachers are better able to elicit performance from students in mathematics at a grade 6 level. Similar results are found by Shepherd (2013) using different data, also at a grade 6 level but for performance in reading literacy. More must be done to fully understand this finding and to further investigate the reasons for differences in the ability of teachers of different ages to affect student performance. Differences in the training received by teachers in universities and universities of technology and that received by teachers trained at teacher training colleges need to be understood. How exactly do these differences translate into student learning? Are there unobservable characteristics according to which teachers differ that are correlated with age? If so, what should be done to ensure that student have access to teachers with these characteristics?

Conclusion

How attractive is the teaching profession and which teachers are considered most effective?

This thesis provides an economic perspective on teachers in the South African education system. The challenges facing education in South Africa are vast and complicated and require research from different perspectives and disciplines to arrive at appropriate policy responses. Indeed, even the challenges surrounding one aspect of the education system (teachers) require a broad spectrum of expertise. Economics is, however, well placed to analyse particular aspects of the teachers and the teaching profession and may contribute to understanding how the profession is viewed by prospective teachers. Furthermore, it enables us to quantify the effect of particular teacher characteristics on student performance. This is an admittedly "clinical" and one-dimensional approach to understanding a complex process, a process which in many ways is unique to the individual teacher. However, using econometric techniques to investigate this relationship can reveal important patterns that warrant further investigation and may therefore be thought of as an initial step in understanding the intricacies of the process of teaching.

Attracting high quality teachers to the profession is one of the key challenges facing the South African education system. As reviewed in chapter 1 and to some extent in chapter 3 (although this literature focuses specifically on the teacher characteristics that most significantly affect student performance), considerable evidence exists on the importance of teacher behaviour in achieving desirable education outcomes. High quality teaching is paramount to achieving acceptable levels of student performance and may well mitigate some of the issues brought about by lack of access to other education resources.

Internationally then it is important to convince highly able individuals to become teachers. A key consideration in career choice is remuneration. Individuals' willingness to pursue a career is to some extent correlated with the wage return to their level of educational attainment, as well as the extent to which their remuneration is likely to grow as they accumulate more experience in their role. An age wage profile that rewards additional years in the profession is likely to convince all teachers to remain in the profession longer but, more importantly, is likely to convince highly able teachers to remain in the profession. If the age-wage profile associated with teaching is unattractive (relative to those associated with other professions), the individuals most able to leave teaching and enter other professions (i.e. highly able teachers) are most likely to leave the profession.

Chapter 1 investigated the attractiveness of the teaching profession from a wage perspective. The results suggest that the returns to higher levels of education for teachers are significantly lower for teachers than they are for all non-teachers with at least 12 years of educational attainment in the South African labour market. Importantly, the gap between the labour market returns to education for teachers and non-teachers increases at higher levels of education, suggesting that from a wage perspective, the teaching profession for highly educated individuals is not an attractive option. The age-wage profiles drawn for teachers appears to increase remarkably between 2007 and 2010, in that both the non-parametric local polynomial smoothed lines and the profile drawn from the Mincerian wage function indicate that the age-wage profile for teachers has improved somewhat since 2007.

Simulating the combinations of education and potential experience for which the wage returns to teaching are higher than they are for non-teaching occupations reveals that teaching is an attractive option only for individuals without degrees and lower experience. From a wage perspective teaching does not appeal to individuals with degrees or postgraduate qualifications. This finding aligns with the finding that the distribution of matric mathematics and language marks for those enrolled in the education faculty at the University of Stellenbosch are significantly weaker than those of students enrolled in other faculties. Furthermore, a lower proportion of education students took higher grade mathematics as a matric subject. It therefore appears that from the perspective of ability (in so far we assume that this is captured by matric performance), prospective teachers fall within the weaker part of the distribution of cognitive outcomes.

As discussed earlier, attracting highly able individuals to the teaching profession is key to achieving high quality education. An ideal scenario would be to ensure that all those entering the teaching profession come from the upper end of the ability distribution. However, the evidence from the University of Stellenbosch (albeit not representative of South Africa as a whole) suggests that this is unlikely to be the case. It is necessary therefore to ensure that individuals who have already joined the profession perform to the best of their ability. Teacher incentives have proved effective internationally in improving student performance. Furthermore, in addition to improving the performance of individuals already in the teaching profession, the introduction of incentives may induce those best able to elicit strong student performance (i.e. high quality teachers) to enter the profession since they stand to benefit from their implementation.

Chapter 1 therefore "updates" what we currently know about the relative position of teachers in the wage distribution. The absence of wage data for 2008 and 2009 is unfortunate as it appears that important changes in favour of teachers took place between 2007 and 2010. This is an important finding and one that should be communicated to prospective teachers. In terms of attracting highly able candidates to the profession, this type of analysis may prove extremely useful both from the perspective of understanding how labour market participants view teaching from a remuneration perspective and also for the purpose of assessing whether the widely-held opinion of teaching as an underpaid profession is valid.

Chapter 2 investigated teacher incentives in education. The potential for distortive behaviour on the part of teachers was highlighted by Holstrom and Milgrom's multitasking model. The danger of individuals behaving in a way that improves performance *measures* without actually improving outcomes is not particular to teachers and education. It is prevalent across incentive systems and in the case of education could lead to a scenario in which student performance on standardised tests improves without any genuine learning taking place. Importantly and relevant in the context of South Africa is the hypothesis that if student performance is exceptionally weak, even distortive "teaching to the test" may represent an improvement in education outcomes since students will learn more than they would in the absence of such incentives. In other words, some learning is taking place in a situation where previously very little was taking place.

Evidence of the use of incentives for teachers is presented from numerous countries. In the majority of cases, incentives improve student performance. However, the context of education in South Africa needs to be considered when investigating the possibility of implementing incentives. The level of inequality characterising the South African education system (and indeed many education system internationally, in both developed and developing countries) makes it difficult to implement any kind of incentive scheme in which teachers are ranked according to their performance (or the performance of their students) without inadvertently favouring teachers in schools with higher socioeconomic status. Incentive systems from two countries, Chile and Brazil, are useful examples of circumventing some of the issues associated with high levels of inequality. In those countries schools are divided, ranked and rewarded according to region and socioeconomic group (in the case of Chile) and according to their level of performance (in the case of Pernambuco, Brazil), which deals to some extent with the unfairness inherent in comparing schools drawing children from highly different parts of the SES distribution

Comparing teachers and schools with relevant peers does not, however, take care of the fact that teacher incentives are awarded on the basis of student performance on standardised tests. Numerous factors – a large number of which are outside the teacher's control - affect student performance. An attractive aspect of teacher incentives in place in Chile and one that to some extent remedies the problem of awarding incentives on the basis of only one noisy measure of teacher performance is the multidimensional measure according to which teachers are rewarded. The fact that teachers are given multiple opportunities for evaluation as well as the fact that they are evaluated according to different criteria means that student performance is not the only measure dictating the awarding of incentives.

In terms of incentives amongst South African teachers, the current monitoring of teacher performance (IQMS), very little exists in terms of formal systems put in place to elicit high levels of effort from teachers.

Incentivising teacher performance is useful and effective if it does in fact result in increased effort and improved performance of teachers and ultimately their students. However, incentives may not prove as useful and desirable if they are not able to affect teacher behaviour. Hanushek (2011) puts forward an argument for "deselecting teachers", arguing that low quality teachers cannot be turned into high quality teachers. Therefore, if the objective is a high quality teaching force, then high quality teachers must be drawn into the teaching force. "The idea is that policies be put in place to identify the most-ineffective teachers and to move them out of the classroom" (Hanushek, 2011: 174). According to Hanushek, unless the bottom 5 to 10 percent of teachers are permanently removed from the teaching force, there is little hope of attaining the illusive high quality teaching force (Hanushek, 2011: 174). Hanushek (2011: 175) points out that deselection of teachers (i.e. forcing weakly performing teachers out of the profession) may well result in higher ability individuals entering the teaching profession since more risk-averse (and lower ability) people would be more likely to avoid the teaching profession while those more convinced of their ability to deliver good results may be more willing to be evaluated and judged on their performance. Another impact of forcing weak teachers out of teaching may be higher levels of efficiency in professional development, for example. In the absence of evaluation of teacher performance, the quality and usefulness of professional development programs are of secondary importance. However, in the case where teacher effectiveness will be evaluated and in cases where this evaluation is high-stakes, teachers certainly have more incentive to participate in high quality professional development programmes in order to genuinely improve their performance (Hanushek, 2011: 175). This is an example of where the "sorting" effect of incentives may come into play by discouraging those unable to perform at the required level from joining the teaching profession. Whether this is feasible in South Africa is questionable, however. The dominance of trade unions in South African teacher labour relations makes it extremely difficult to remove underperforming teachers from schools. Unless there is a willingness amongst union leadership to improve the quality of teacher in South Africa and as is the case in Chile, to some extent take responsibility for and become involved in the process of improving teacher quality, it is unlikely that negative incentives (i.e. incentives that "punish" poor performance as opposed to rewarding good performance) will be effective in the South African education system.

Having investigated the prospects for ensuring high ability individuals enter the profession as well as the prospects of improving the performance of people already in the profession, chapter 3 investigated which teacher characteristics are associated with improved student performance. Analysis using hierarchical linear modelling to control for characteristics at the level of both the individual student and the teacher by whom they are taught reveals that younger teachers are significantly more efficient at eliciting stronger student performance. Interestingly, this result is not observed in other Sub-Saharan African countries. In order to test whether this result is observed for all South African teachers (as opposed to just the youngest cohort of teachers observed in the 2007 SACMEQ III study), identical models were run using an almost identical dataset from seven years earlier (SACMEQ II study, conducted in 2000). Interestingly, the result appears only in South Africa in SACMEQ III. Younger teachers in this study also perform better on the teachers' mathematics test than did their older counterparts, another result that is observed only amongst South African mathematics teachers.[44] Shepherd (2013) finds similar results using grade 6 reading literacy data. The source of this differentiation is important to determine. This is an extremely important result and one that needs to be investigated further

[44] South African teachers did not take the teacher mathematics test in the SACMEQ II study. It is therefore not possible to see whether the pattern of younger teacher outperformed teacher in older cohorts was present in 2000.

in order to understand what drives this relationship. The fact that the positive effect of younger teachers can be quantified in the South African context and not in the other countries for which the model was run is very interesting and requires more focussed future work.

A possible explanation for the differences in teachers' ability to affect student performance is the shift in the institutions in which teachers were trained from teacher training colleges to universities and universities of technology. This explanation would account for the fact that the relationship between teacher age and student performance is not observed in earlier studies (SACMEQ II) and why it is not seen in other Sub-Saharan African countries. The availability of data from the SACMEQ IV study (scheduled for implementation between 2012 and 2014) will allow for the investigation of whether this cohort of teachers, now older, still outperforms their older counterparts and whether still younger cohorts appear to be better teachers than their older colleagues. If a change in teacher training is the correct explanation for the observed differences, it is important to understand it better as it is widely believed that the shifting of teacher training to universities and universities of technology was ill-suited to the needs of the education system. Further investigation into the nature of the training received by teachers and the impact that this has on student performance is required.

This thesis used analytical tools from economics to investigate questions around teacher quality. The wage structure faced by teachers is relatively unattractive when compared to that of non-teaching professionals, but is still somewhat appealing when compared to that faced by non-teachers who would not be classified as professionals and those with lower levels of educational attainment. Furthermore, the age-wage profile for teachers is considerably less attractive than observed for all non-teachers in the labour market. It is hypothesised that this may serve to discourage highly able individuals from joining the teaching force – a hypothesis which seems to be supported by data from the University of Stellenbosch. In terms of incentives to improve teacher effort and ultimately student performance, very few (if any) explicit incentives are in place in South Africa. Although the infrastructure for such monitoring is in place in the form of the IQMS and to some extent the ANAs, these are both low stakes and are unlikely to elicit higher levels of teacher effort. Finally, students seem on average to perform better when being taught by younger teachers. A possible explanation for this observation is the change in the institutions responsible for training teachers that were concluded in 2000, with the closure of teacher training colleges and the incorporation of some of these into universities and universities of technology. However, this requires more investigation.

Chapter 1 looked at the wage prospects facing individuals when they decide whether or not to enter the teaching profession. In some way, this can be thought of one of the factors determining whether highly able individuals (who are assumed to be high quality teachers) will join the teaching profession and so may be thought of as the first step in ensuring a high quality teaching force. Chapter 2 then investigated the possibilities for using incentives to enhance teacher quality amongst those already in the system. The first two chapters therefore look at the issues of securing high quality teachers and enhancing the quality of teaching amongst those already in the profession. Chapter 3 then focused more on a question that is investigated using education production function type analysis, investigating the characteristics of teachers associated with high levels of student performance. Younger teachers appear to be better able to elicit strong performance from students. Furthermore, they appear to perform better on teacher tests than their older counterparts. A possible explanation for this is the changes that took place in teacher training during the late 1990s and early 2000s which saw the closing of teacher training colleges and the relocation of teacher training to universities and universities of technology.

Appendix A

FIGURE A1: Boxplots of annual earnings (2000–2007)

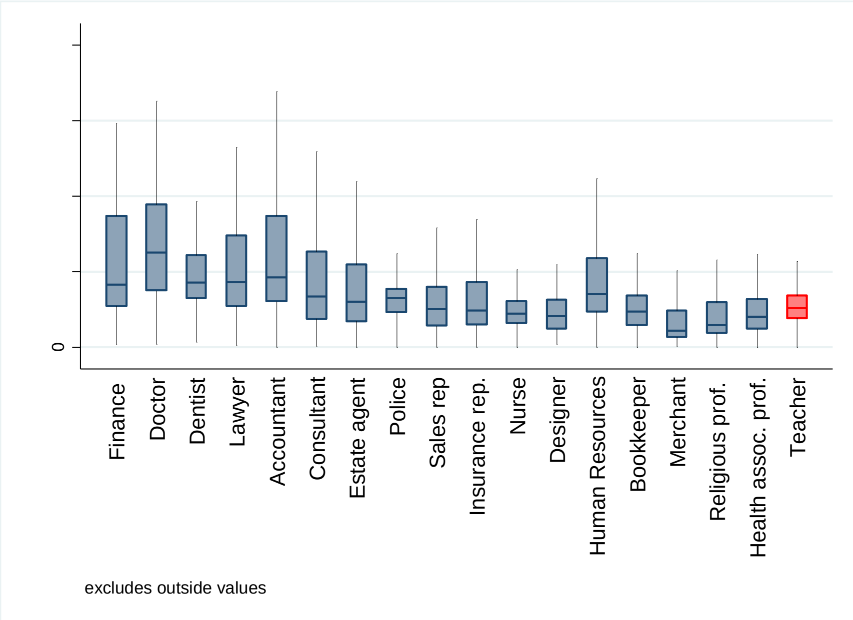


FIGURE A2: Boxplots of annual earnings (2010)

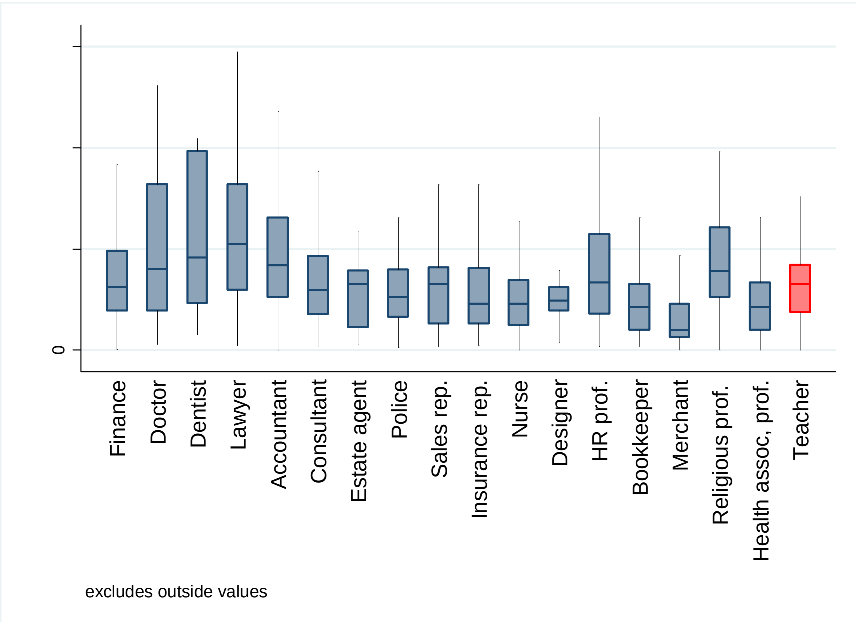


TABLE A1: Non-teaching professionals in the LFS (2000–2007) and QLFS (2010)

NON-TEACHING PROFESSIONALS
Business professionals
Legal professionals
Archivists, librarians and related information professionals
Social science and related professionals
Writers and creative or performing artists
Religious professionals
College, university and higher education teaching professionals
Health professionals (except nursing)
Life science professionals
Physical sciences technologists
Computing professionals
Architects, engineers and related professionals
Mathematicians, statisticians and related professionals
Physicists, chemists and related professionals

TABLE A2: Variables included in augmented Mincerian wage function

VARIABLE	DESCRIPTION
13 years of education	A dummy variable taking the value of 1 if the worker has 13 years of education and 0 otherwise.
15 years of education	A dummy variable taking the value of 1 if the worker has 15 years of education and 0 otherwise.
16 years of education	A dummy variable taking the value of 1 if the worker has 16 years of education and 0 otherwise.
17 years of education	A dummy variable taking the value of 1 if the worker has 17 years of education and 0 otherwise.
Educ	A continuous variable reflecting the number of years of education an individual has completed.
$Educ^2$	A quadratic term (number of years of education squared) included to control for the possibility of non-linearities in the returns to education.
Exp	A continuous variable reflecting the number of years the worker has been employed in the labour market (calculated as [age – 6 – years of educational attainment])
Exp^2	A quadratic term (number of years of experience squared) included to control for the possibility of non-linearities in the returns to experience.
Union[45]	A dummy variable taking the value of 1 if the workers is a union member and 0 otherwise.
Female	A dummy variable taking the value of 1 if a worker is female and 0 otherwise.
Tenure	A continuous variable controlling for the number of years a worker has worked for their current employer.
Teacher	A dummy variable taking the value of 1 if the worker is a teacher and 0 otherwise.
Black	A dummy variable taking the value of 1 if the worker is black and 0 otherwise.
Coloured	A dummy variable taking the value of 1 if the worker is coloured and 0 otherwise.
Indian	A dummy variable taking the value of 1 if the worker is Indian and 0 otherwise.
White	A dummy variable taking the value of 1if the worker is white and 0 otherwise.

[45] Not available in the QLFS 2010

Agriculture	A dummy variable taking the value of 1 if the worker is employed in the agriculture, hunting, forestry and fishing industry and 0 otherwise.
Mining and quarrying	A dummy variable taking the value of 1 if the workers is employed in the mining and quarrying industry and 0 otherwise.
Manufacturing	A dummy variable taking the value of 1 if the worker is employed in the manufacturing industry and 0 otherwise.
Electricity, gas and water supply	A dummy variable taking the value of 1 if the worker is employed in the electricity, gas and water supply industry.
Construction	A dummy variable taking the value of 1 if the worker is employed in the construction industry and 0 if otherwise.
Wholesale and retail	A dummy variable taking the value of 1 if the worker is employed in the wholesale and retail industry and 0 if otherwise.
Transport, storage and communication	A dummy variable taking the value of 1 if the worker is employed in the transport, storage and communication industry and 0 if otherwise.
Finance, insurance and business	A dummy variable taking the value of 1 if the worker is employed in the financial, insurance and business services industry and 0 otherwise.
Community, social and personal services	A dummy variable taking the value of 1 if the worker is employed in the community, social and personal services industry.
Private households	A dummy variable taking the value of 1 if the worker is employed in the private households industry.
Western Cape	A dummy variable taking the value of 1 if the worker is employed in the Western Cape and 0 otherwise.
Eastern Cape	A dummy variable taking the value of 1 if the worker is employed in the Eastern Cape and 0 otherwise.
Northern Cape	A dummy variable taking the value of 1 if the worker is employed in the Northern Cape and 0 otherwise.
Free State	A dummy variable taking the value of 1 if the worker is employed in the Free State and 0 otherwise.
KwaZulu-Natal	A dummy variable taking the value of 1 if the worker is employed in KwaZulu Natal and 0 otherwise.
Northwest	A dummy variable taking the value of 1 if the worker is employed in Northwest and 0 otherwise.
Gauteng	A dummy variable taking the value of 1 if the worker is employed in Gauteng and 0 otherwise.
Mpumalanga	A dummy variable taking the value of 1 if the worker is employed in Mpumalanga and 0 otherwise.
Limpopo	A dummy variable taking the value of 1 if the worker is employed in Limpopo and 0 otherwise.

Source: LFS 2000–2007, QLFS 2010

TABLE A3: Means (and standard deviations) of variables used

VARIABLE	GROUP			
	Teachers (N = 6 274)	Non-Teachers (N = 439 551)	Teachers (N = 3 225)	Non-Teachers (N = 47 037)[46]
	2000 - 2007		2010	
Log Hourly Wage	3.35	1.93	3.04	2.71
	(1.18)	(0.63)	(0.450)	(0.564)
Educ	13.71	9.55	13.73	12.66
	(1.45)	(3.91)	(1.321)	(1.185)
Exp	20.37	20.86	23.47	16.86
	(8.51)	(12.59)	(9.289)	(9.689)
Exp^2	414.94	435.14	644.16	524.09
	(362.21)	(660.47)	(445.45)	(555.52)
Union	0.80	0.35	-	-
	(0.472)	(0.478)		
Female	0.69	0.44	0.68	0.44
	(0.46)	(0.50)	(0.466)	(0.496)
Tenure	12.29	6.47	12.35	6.62
	(8.916)	(7.014)	(8.645)	(7.256)
Black	0.71	0.51	0.67	0.56
	(0.453)	(0.500)	(0.471)	(0.496)
Coloured	0.08	0.11	0.08	0.12
	(0.266)	(0.313)	(0.275)	(0.324)
Indian	0.03	0.06	0.04	0.06
	(0.171)	(0.243)	(0.187)	(0.273)
White	0.18	0.31	0.21	0.26
	(0.384)	(0.463)	(0.411)	(0.438)
Industry 1	0.00	0.02	0.00	0.03
	(0.023)	(0.142)	(0.000)	(0.168)
Industry 2	0.00	0.03	0.00	0.16
	(0.000)	(0.181)	(0.00)	(0.367)
Industry 3	0.00	0.16	0.00	0.01
	(0.014)	(0.366)	(0.000)	(0.109)
Industry 4	0.00	0.01	0.00	0.05
	(0.024)	(0.114)	(0.000)	(0.216)
Industry 5	0.00	0.03	0.00	0.21
	(0.000)	(0.180)	(0.000)	(0.405)
Industry 6	0.00	0.20	0.00	0.06
	(0.013)	(0.402)	(0.000)	(0.243)
Industry 7	0.00	0.06	0.00	0.20
	(0.033)	(0.240)	(0.000)	(0.398)
Industry 8	0.00	0.18	1.00	0.28
	(0.009)	(0.383)	(0.000)	(0.450)
Industry 9	0.99	0.29	0.00	0.00
	(0.050)	(0.454)	(0.000)	(0.027)
Industry 10	0.00	0.00	-	-
	(0.00)	(0.070)		
Western Cape	0.08	0.15	0.10	0.15
	(0.268)	(0.359)	(0.295)	(0.352)
Eastern Cape	0.16	0.08	0.15	0.08
	(0.368)	(0.271)	(0.362)	(0.278)
Northern Cape	0.02	0.01	0.04	0.02
	(0.133)	(0.118)	(0.184)	(0.127)
Free State	0.07	0.06	0.07	0.05
	(0.256)	(0.240)	(0.262)	(0.215)
KwaZulu-Natal	0.20	0.18	0.21	0.18
	(0.403)	(0.388)	(0.408)	(0.308)
Northwest	0.08	0.06	0.05	0.05
	(0.266)	(0.235)	(0.218)	(0.216)
Gauteng	0.18	0.34	0.19	0.38
	(0.383)	(0.473)	(0.393)	(0.486)
Mpumalanga	0.06	0.06	0.08	0.06

[46] The ratio of teachers to non-teachers in the South African labour market appears to be different between the pooled sample of 2000 to 2007 and 2010. This is likely due to missing values for variables in the 2010 data.

	(0.2233)	(0.231)	(0.273)	(0.236)
Limpopo	0.16	0.05	0.11	0.04
	(0.365)	(0.218)	(0.307)	(0.197)

Note: Own calculations from LFS 2000–2007 and QLFS 2010, Stats SA

TABLE A4: Regression estimates for augmented Mincerian wage function on log hourly wages (2000–2007)[1]

Variable	Sub-Sample		
	Teachers	**Non-teachers (all levels of education)**	**Non-teachers (at least 10 years of education)**
Education	0.074 (20.11)***	0.111 (187.39)***	0.254 (165.36)***
Experience	0.018 (6.74)***	0.014 (28.17)***	0.029 (35.89)***
Experience^2	0.000 (-5.92)***	0.000 (-7.09)***	0.000 (-23.64)***
Female	-0.066 (-5.67)***	-0.162 (-48.57)***	-0.152 -35.46)***
Married	0.008 (0.67)	0.144 (42.75)***	0.141 (30.55)***
Union	0.259 (18.06)***	0.276 (76.11)***	0.227 (48.52)***
Tenure	0.007 (8.33)***	0.016 (68.53)***	0.018 (49.27)***
Constant	0.767 (3.22)***	-0.039 (-4.04)***	-1.817 -78.74)***
Adjusted R-Squared	0.1106	0.5421	0.4929
No. Of Observations	12142	252 697	139 040

*Source: Own calculations from LFS (March and September) 2000–2007, Stats SA. Race, province and industry are controlled for in these regressions. Standard errors are reported in parentheses. *, ** and *** indicate that coefficients are significant at a 10%, 5% and 1% level, respectively.*

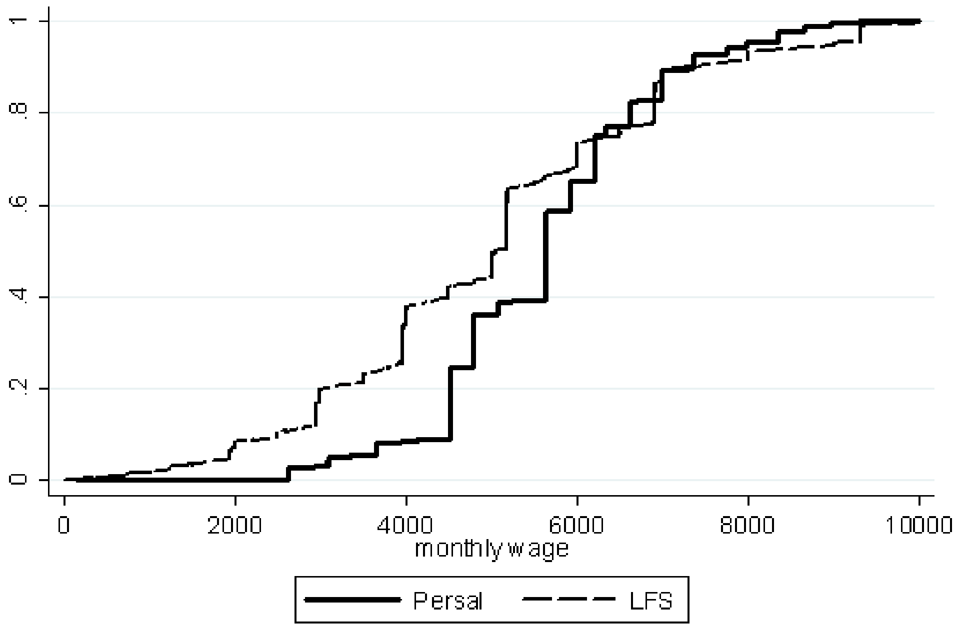
UNDER-REPORTING OF EARNINGS BY TEACHERS

The previous section compares teacher earnings to those of their non-teaching counterparts in the South African labour market. As mentioned before, it makes use of data from the Labour Force Survey (LFS). The validity of any of the results therefore is dependent on the validity of the information contained in the LFS.

The extent of underreporting of earnings by teachers in the LFS may be gauged by comparing the earnings data in LFS to what is actually paid to teachers by the Department of Basic Education. In order to do this, Persal data is used to compare reported earnings amongst teacher (in LFS) to wages paid to teachers (Persal). The comparison is conducted using the September 2001 Persal download and the 2001 LFS.

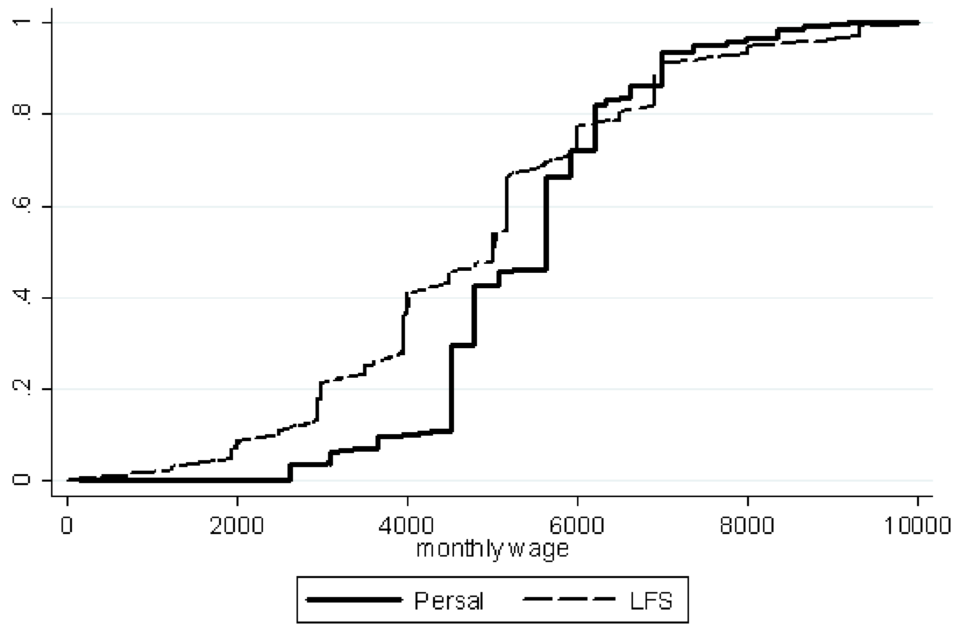
Using cumulative density functions (CDFs), we are able to see the proportion of teachers reporting a given level of monthly earnings in the LFS and how this compares to the proportion of teachers recorded as earning that wage from Persal data. CDFs for all teachers, for black teachers and for white teachers are presented in figures A3, A4 and A5 below.

Figure A3: Cumulative Density Functions: all teachers (2001)



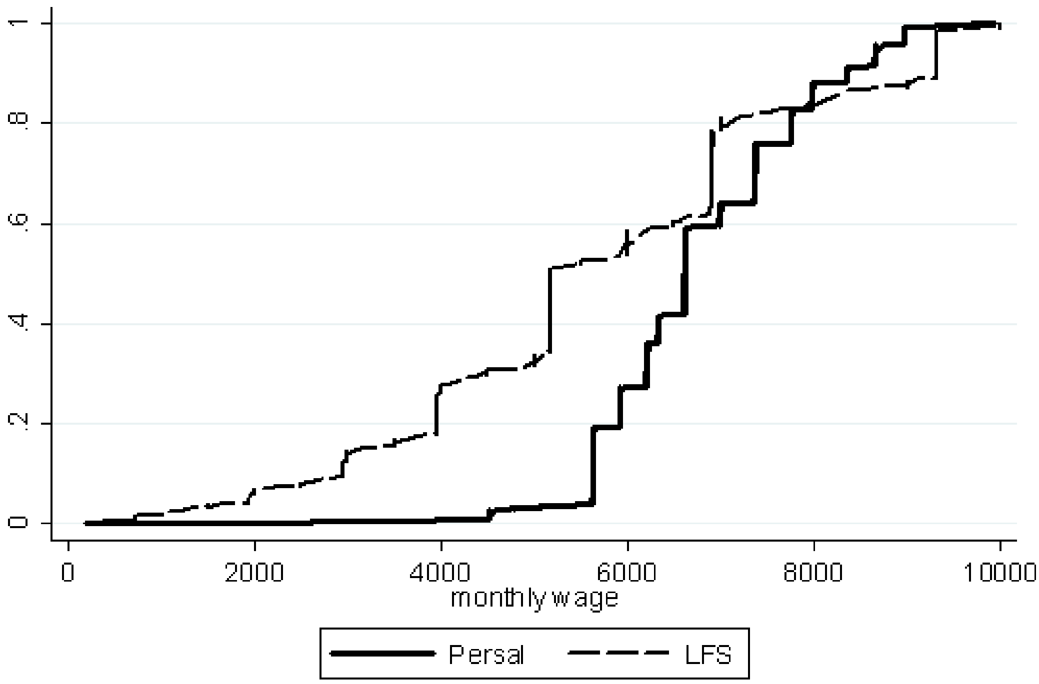
Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001

Figure A4: Cumulative Density Function: black teachers (2001)



Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001

Figure A5: Cumulative Density Function: white teachers (2001)



Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001

From the figures, it is clear that a fair amount of underreporting of earnings occurs amongst teachers in the LFS. The CDFs for teachers in the LFS lie above those of teachers in the Persal data at lower level of monthly wages, indicating that a higher proportion of teachers in the LFS report lower levels of earnings than what is recorded in the Persal data. Similarly, a lower proportion of teachers report higher levels of monthly earnings in the LFS than what is recorded in the Persal data. Interestingly, it appears that the extent of underreporting amongst white teachers is slightly higher than it is for black teachers.

Given the evidence that reported earnings of teachers are lower than what is reflected in the Persal data, it is important to investigate the impact that this is likely to have on returns to education amongst teachers as well as on the age-wage profile of teachers. In order to investigate this impact, a Mincerian wage regression is run in which the log of monthly earnings is regressed against the level of teacher training obtained as well as a quadratic term for age. A dummy variable is included for teachers capture in the LFS and the age and training terms are interacted with the LFS dummy. The results are presented in table A5 below.

Table A5: Regression estimates for augmented Mincerian wage function on log monthly wages (2001)

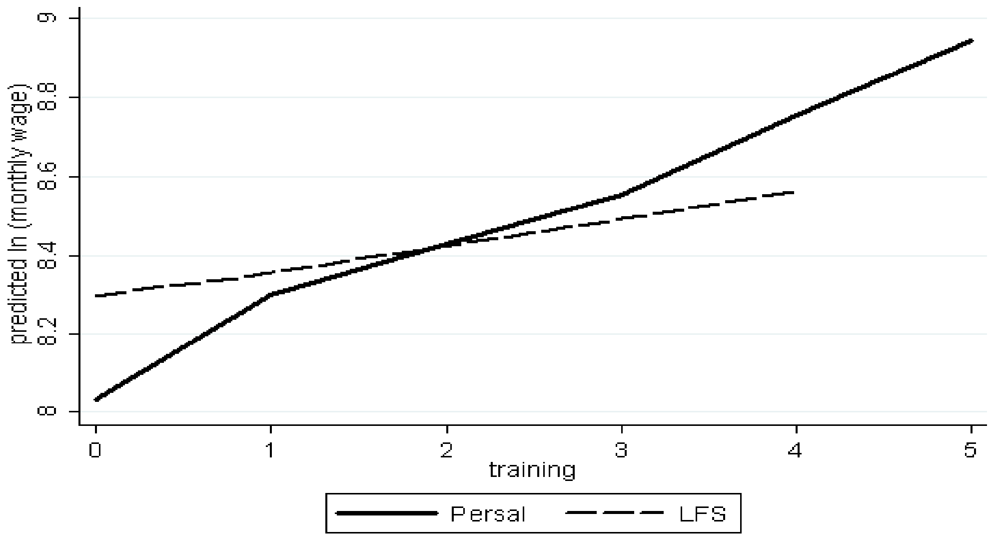
Variable	
Training	0.1602
	(69.03)***
Age	0.0324
	(11.92)***
Age ^{2}	-0.0003
	(-8.70)***
Training x LFS	-0.1013
	(-41.74)***
Age x LFS	0.0321
	(11.12)***
Age^2 x LFS	-0.0004
	(-11.17)***
LFS	-0.4433
	(-7.61)***
Constant	7.3243
	(133.12)***
R-squared	0.1192
No. of observations	316 724

Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001. Race, province and gender are controlled for in these regressions.

Interesting to note is that the LFS dummy variable is negative, indicating that teachers who are captured in the LFS report lower monthly wages on average than what is reported in Persal.

In terms of the returns to training implied by the coefficients obtained in table A5, figure A6 presents the returns to earnings for teachers captured in the LFS and those implied by the data contained in Persal.

Figure A6: Returns to training, 2001

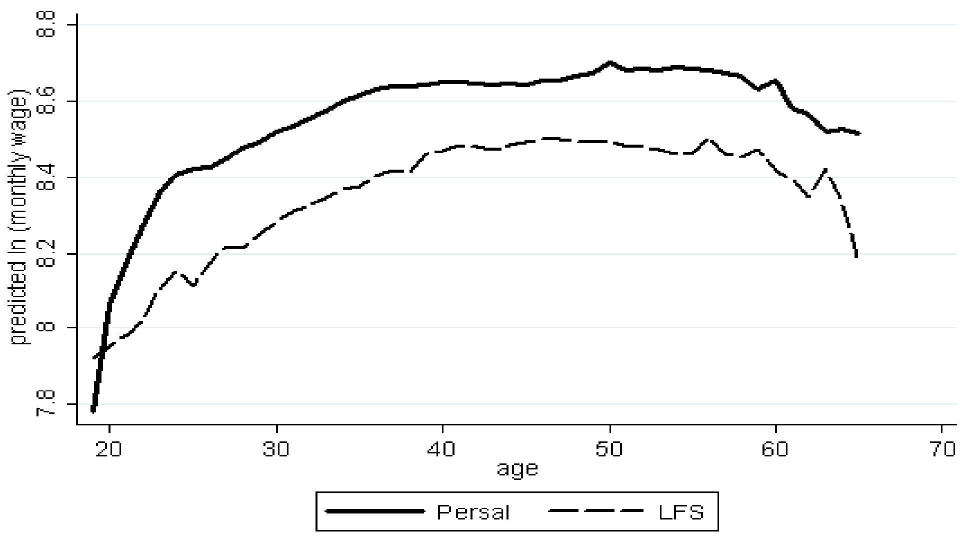


Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001

Figure A4 indicates that according to the data recorded in Persal, monetary returns to training amongst teachers appear to be higher at higher levels of training than what is reported in LFS, suggesting that the teaching profession for individuals with relatively high levels of education is perhaps not as unattractive as is suggested by the earnings reported in the LFS.

The age-wage profile associated with earnings reported in the LFS and the Persal data is presented in figure A7 below.

Figure A7: Age-wage profile, 2001



Source: Own calculations from Persal (September) 2001 and LFS (March and September) 2001

From figure A5, we see that although the profile is lower at all age for teachers captured in the LFS, is appears that the age-wage profile takes a similar shape for both the LFS and the Persal data, with the exception of the oldest teachers in the data. For these teachers, monthly earnings in the LFS appear to drop by a significantly greater amount after the age of roughly 61 or 62 than they do in the Persal data.

This brief analysis has therefore pointed out that there is evidence of underreporting of earnings amongst teachers in the LFS relative to what is recorded in the Persal dataset. It is important to bear in mind that the unattractiveness of the teaching profession implied in the previous section of this paper may thus be overstated.

Appendix B

TABLE B1: OLS estimates obtained after clustering standard errors (SACMEQ III, 2007)

Variable	Model 1		Model 2	
	Coefficient	**Std deviation**	**Coefficient**	**Std deviation**
Intercept	-0.122	0.111	-0.185*	0.112
TEACHER DEMOGRPAHIC CHARACTERISTICS				
Female	0.095***	0.016	0.101***	0.017
30 to 39 years of age	-0.488***	0.054	-0.467***	0.054
40 to 49 years of age	-0.553***	0.054	-0.483***	0.055
50 to 59 years of age	-0.669***	0.065	-0.582***	0.065
60 years and older	-0.475***	0.126	-0.444***	0.126
TEACHER EDUCATION AND EXPERIENCE				
Teacher maths score			0.101***	0.011
Experience: 6 to 10 years	0.166***	0.033	0.131***	0.033
Experience: 11 to 15 years	0.121***	0.023	0.071***	0.024
Experience: 16 to 20 years	-0.045	0.028	-0.095***	0.030
Experience: 21 to 25 years	0.031	0.032	-0.031	0.033
Experience: 26 to 30 years	0.222***	0.059	0.170***	0.061
Experience: 31 to 35 years	0.290***	0.061	0.234***	0.062
Experience: 36 to 40 years	0.027**	0.108	-0.001	0.108
Experience: 41 plus years	-0.395**	0.166	-0.383**	0.166
Number of days training received	0.246*	0.153	0.162	0.154
Trained in mathematics	-0.320**	0.152	-0.257*	0.153
Trained to teach mathematics	0.023	0.062	-0.023	0.062
Completed jr secondary education	0.023	0.031	0.008	0.031
Completed sr secondary education	0.056**	0.027	0.014	0.029
Completed A-levels	0.069***	0.022	0.049**	0.023
Completed a degree	0.924***	0.184	1.034***	0.266
Received less than 1 year of training	0.447***	0.115	0.452***	0.116
Received 1 year of training	0.520***	0.109	0.575***	0.110
Received 2 years of training	0.413***	0.105	0.471***	0.105
Received 3 years of training	0.488***	0.105	0.526***	0.105
Received 3 years plus of training	0.166***	0.033	0.131***	0.033
TEACHER EFFORT				
Parents sign students' homework	0.055***	0.018	0.056***	0.019
Test 2 to 3 times per term	0.054*	0.028	0.043	0.029

Tests 2 to 3 times per month	0.016	0.031	0.028	0.031
Tests at least once per week	0.124***	0.031	0.131***	0.032
SCHOOL AND CLASSROOM CHARACTERISTICS				
Rural	-0.031	0.021	-0.031	0.022
Classroom SES	0.522***	0.021	0.474***	0.023
Private school	0.017	0.038	0.023	0.038
Average class size (of the school)	0.017	0.038	0.023	0.038
STUDENT CHARACTERISTICS				
SES	0.047***	0.017	0.050***	0.017
Overage	-0.118***	0.026	-0.109***	0.027
Female	-0.009	0.019	-0.008	0.020
Mother completed matric	0.092***	0.022	0.096***	0.023
Father completed matric	0.071***	0.021	0.075***	0.022
Less than 1 year preschool	0.008**	0.042	-0.006	0.043
1 year of preschool	0.047***	0.022	0.053**	0.024
2 years of preschool	0.083***	0.030	0.067**	0.032
3 or more years of preschool	0.166***	0.028	0.157***	0.030
Speaks English sometimes	0.165***	0.022	0.165***	0.023
Speaks English most of the time	0.196***	0.038	0.180***	0.040
Speaks English always	0.320***	0.050	0.316***	0.051
Repeated a grade once	-0.188***	0.027	-0.192***	0.027
Repeated a grade twice	-0.243***	0.043	-0.280***	0.045
Repeated a grade three times	-0.281***	0.050	-0.306***	0.053
Repeated grade 6	0.081**	0.036	-0.053	0.038
Receives extra tuition	-0.070**	0.031	-0.026	0.032
R-squared	0.424		**0.438**	
Number of teachers	497		469	
Number of students	8 917		8336	

Source: Own calculations from SACMEQ III (SACMEQ, 2007).

TABLE B2: Full Hierarchical Linear Model (SACMEQ II, 2000)

Variable	Coefficient	Std deviation
Intercept	0.048	0.176
TEACHER DEMOGRAPHIC CHARACTERISTICS		
Female	0.083	0.077
30 to 39 years of age	0.003	0.120
40 to 49 years of age	0.315*	0.189
50 years and older	0.671**	0.232
60 years and older	-	
TEACHER EDUCATION AND EXPERIENCE		
Teacher maths score	-	
Experience: 6 to 10 years	-0.17	0.118
Experience: 11 to 15 years	-0.245*	0.139
Experience: 16 to 20 years	-0.431*	0.229
Experience: 21 to 25 years	-0.454**	0.194
Experience: 26 to 30 years	-0.803***	0.259
Experience: 31 to 35 years	-0.952**	0.413
Experience: 36 plus	-0.603**	0.292
Number of days training received	-0.001**	0.001
Trained in mathematics	-	
Trained to teach mathematics	-	
Completed jr secondary education	-0.082	0.275
Completed sr secondary education	0.243	0.157
Completed A-levels	0.473***	0.115
Completed a degree	0.403***	0.126
Received less than 1 year of training	-	
Received 1 year of training	-	
Received 2 years of training	-0.588***	0.179
Received 3 years of training	-0.351*	0.196
Received 3 years plus of training	-0.412***	0.096
TEACHER EFFORT		
Parents sign students' homework	0.014	0.095
Test 2 to 3 times per term	-	
Tests 2 to 3 times per month	0.135	0.184
Tests at least once per week	0.111	0.099

SCHOOL AND CLASSROOM CHARACTERISTICS		
Rural	-0.061	0.096
Classroom SES	0.506***	0.062
Private school	0.291	0.336
Average class size (of the school)	-0.003	-0.004
STUDENT CHARACTERISTICS		
SES	0.065***	0.019
Overage	-0.148***	0.023
Female	-0.027	0.025
Mother completed matric	-0.024	0.026
Father completed matric	0.061**	0.025
Less than 1 year preschool	-	
1 year of preschool	-	
2 years of preschool	-	
3 or more years of preschool	-	
Speaks English sometimes	0.115***	0.036
Speaks English most of the time	0.221***	0.050
Speaks English always	-	
Repeated a grade once	-0.140***	0.030
Repeated a grade twice	-0.148***	0.043
Repeated a grade three times	-0.242***	0.048
Repeated grade 6	0.046	0.035
Receives extra tuition	0.060*	0.033

	Standard Deviation	Variance	Chi-Squared
Intercept	0.416	0.173	3 468.531
Within-classroom	0.651	0.424	

	Reliability of teacher-level random effects
Mean score	0.852

Source: Own calculations from SACMEQ III (SACMEQ, 2007).

Appendix C

Minimum requirements for teacher education qualifications

The Government Gazette No. 34467 of 2011 on *Minimum Requirements for Teacher Education Qualifications* lists the professional and academic qualifications selected for teacher education (DHET, 2011):

i. **Qualifications for initial teacher education (ITE):**

Bachelor of Education degree

Advanced Diploma in Teaching

ii. **Qualifications for the continuing professional and academic development of teachers:**

Advanced Certificate in Teaching

Advanced Diploma in Education

Postgraduate Diploma in Education

Bachelor of Education Honours degree

Master of Education degree

Doctoral degree

iii. **Qualification for grade R teaching:**

Diploma in grade R teaching

Students enrolled in ITE programmes are students who may be considered part of the potential stock of future teachers. It is possible and probable that students enrolled in continuing professional and academic development may already belong to the teaching force, or that they have continued from initial teacher education.

The gazette explains that "[t]he primary purpose of all Initial Teacher Education qualifications is to certify that the holder has specialized as a beginner teacher in a specific phase and/or subject" (DHET, 2011). Student enrolled in initial teacher education may specialize in a phase, a subject or in a combination of these. Importantly, all students with ITE qualifications are expected to be proficient in at least one official language as a language of learning and teaching (LoLT) as well as being able to use at least one other official language sufficiently for conversational purposes ("partially proficient") (DHET, 2011).

Initial Teacher Education: Bachelor of Education

As listed in point 1 above, a Bachelor of Education degree or an Advanced Diploma in Teaching (in addition to an undergraduate bachelor's degree or an approved diploma). In the case of a Bachelor of Education degree, a graduate is expected to be functional as a classroom teacher with focused knowledge and practical skills in their given specialization (DHET, 2011). Students enrolled in a Bachelor of Education degree can specialize in Foundation Phase (FP) teaching, or in the teaching of subjects from four broad "fields of learning" in either the Intermediate Phase (IP), the Senior Phase (SP) or the Further Education and Training (FET) phase. Table A1 below provides a summary of the possible specializations available to teachers in ITE.

TABLE C1: Teaching specialisation for initial teacher education qualifications

PHASE	**SUBJECT DOMAINS**				**LEARNING SUPPORT SPECIALISATIONS**
	Humanities	**Science and Technology**	**Languages**	**Business and Management**	
FOUNDATION (GRADES R – 3)	Integrated focus on Literacy, Numeracy and Life Skills				
INTERMEDIATE (GRADES 4 – 7)	Life Skills Social Sciences	Science and Technology Mathematics	Languages*		
SENIOR (GRADES 7 – 9)	Arts and Culture Life Orientation Social Sciences	Natural Sciences Mathematics Technology	Languages*	Economic and Management Sciences	School Librarianship Guidance Counselling and Specialised Learning Support Physical Education
FET (GRADES 10 – 12)	Dance Studies Dramatic Arts	Agricultural Sciences Geography	Languages*	Accounting Business Studies	ICT Support

	History	Life Sciences		Economics	
	Life Orientation	Mathematics		Hospitality Studies	
	Music	Mathematical Literacy		Tourism	
	Religion Studies	Physical Sciences			
	Visual Arts	Computer Applications Technology			
		Agricultural Management Practices			
		Civil Technology			
		Electrical Technology			
		Engineering Graphics and Design			
		Information Technology			
		Mechanical Technology			
		Design			
		Consumer Studies			

Source: Department of Higher Education and Training (2011). *Minimum Requirements for Teacher Education Qualifications.*

Teachers are qualified to teach the phase and/or subjects in which they specialised while studying for a Bachelor of Education degree. Of importance in the FP specialisation is that teachers must specialise in First Language teaching in at least one of the official languages, as well as in First Additional Language teaching. Certain stipulations exist regarding which languages teachers must choose. These can be found on page 23 of the *Minimum Requirements for Teacher Education Qualifications*. Students specialising in the IP must specialise in the teaching of at least four subjects indicated in the IP domain in table 1. Because the first year of senior phase is often taught with the intermediate phase, teachers who has specialised in the intermediate phase must be able to teacher grade 7. IP specialists employed to teach subjects at a grade 7 level may enrol for an Advanced Certificate (discussed later) in the SP subject in order to develop competence in the grade 7 subjects which they are to teach (DHET, 2011). In order to teach in secondary schools, teachers must have completed a combined SP and FET programme. Teachers must have completed a minimum of three specialisations: i) two SP subjects and one FET subject; ii) one SP subject and two FET subjects; or iii) one SP subject, one FET subject and one support role. At least one SP subject and as least one FET subject are therefore required for teachers specialising in this combination.

Initial Teacher Education: Advanced Diploma in Teaching

The Advanced Diploma in Teaching "offers entry-level initial professional preparation for graduates and diplomats who wish to develop focused knowledge and skills as classroom teachers in a chosen phase(s) and/or subject(s)" (DHET, 2011). The *Minimum Requirements for Teacher Education Qualifications* stipulates that a Bachelor's degree is the preferred minimum entry requirement for the Advanced Diploma in teaching and that it should include sufficient academic content knowledge of the school subjects in the phase that the student would like to teacher (DHET, 2011). A number of diplomas are also listed as being acceptable for entry into the Advanced Diploma in Teaching. These are presented in Appendix E on page 56 of the *Minimum Requirements for Teacher Education Qualifications*.

The requirements for the Advanced Diploma in Teaching for different phases are largely similar to those stipulated for the Bachelor of Education degree. However, in the case of SP and FET teaching, only two subject specialisations (only one SP subject and one FET subject) are required, whereas a minimum of three is required in the case of the Bachelor of Education. Furthermore, it is possible to specialise only in FET teaching in the case of an Advanced Diploma in Teaching. In this case, the subject in which the students specialises must have been a major subject in the Bachelor's degree or diploma in the qualification through which the student entered the Advanced Diploma in Teaching.

ITE in the form of a Bachelor of Education and Advanced Diploma in Teaching prepares students who have not yet entered the teaching force to do so. Graduates from these programmes may therefore be thought of as "potential teachers" as there is no guarantee that they will enter the teaching profession once they have completed these programmes. The higher education system also provides for teachers who already belong to the teaching force, but who are involved in Continuing Professional Development (CPD). For the sake of this report, the focus will fall on teachers enrolled in the Advanced Certificate in Teaching. It is true that an extensive list of CPD programmes exists, but it is only the Advanced Certificate in Teaching that can qualify teachers to teach in areas that they were previously not qualified to teach rather than enhancing the research or academic qualifications of teachers. The Advanced Certificate in Teaching is therefore the only means of quantifying the potential stock of teachers.

Continuing Professional Development: Advanced Certificate in Teaching

The Advanced Certificate in Teaching is designed to prepare teachers to teach new subjects or phases, or to enhance their knowledge and competence in an existing subject or phase. The certificate was established to address the needs of three sets of teachers:

1. Teachers seeking retraining: These are teachers who would like to specialise in teaching a subject for which they have not previously obtained a professional teaching qualification.
2. Recognition of prior learning (RPL) upgrading: Teachers with prior professional teaching qualifications teaching FP or IP but who did not specialise in the phase. The Advanced Certificate in Teaching allows them to complete a formal qualification in either FP or IP, given that they have obtained the appropriate knowledge by teaching FP or IP.
3. Teachers who completed a three-year diploma in education at a former college of education, or a National Professional Diploma in Education and who want to strengthen their specialisation in their particular subject or phase.

The *Minimum Requirements for Teacher Education Qualifications* stipulates that “the Advanced Certificate may only be utilised for the retraining or upgrading of teachers who hold prior professional teaching qualifications in a subject and/or phase. It is *not* available for new roles in education” (DHET, 2011).

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