RESEARCH REPORT 16

Development Effectiveness Project

May 2014

WITS SCHOOL OF GOVERNANCE
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Platinum & Passes

The Impact of Mining Investments on Education Outcomes in South Africa

Neissan Alessandro Besharati

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Cover photograph caption: Grade 12 learners in Matsibe school, Limpopo Province writing the National Senior Certificate examination in 2013.

ISBN: 978-1-919969-85-5

Please note that all currencies are in US$ unless otherwise indicated.

CONTENTS

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ABOUT THE DEVELOPMENT EFFECTIVENESS PROJECT

The Development Effectiveness Project (DEP) is a joint programme of SAIIA and the Wits School of Governance. It aims to explore the current international development landscape, with its variety of diverse financing mechanisms, approaches, partnership modalities and institutional players, and to gather empirical evidence on what works in development and poverty alleviation in Africa. The DEP aims to develop frameworks, methodologies and instruments for the monitoring, evaluation and analysis of the impact and effectiveness of different development interventions and development partners operating on the continent. The current focus of the research is on two main policy streams namely 1) south–south co-operation and emerging economies; and 2) the role of the private sector in development.

ACKNOWLEDGEMENTS

This report is the product of joint research by SAIIA and the Wits School of Governance, with input from the Wits schools of Education, Economics and Statistics. The research was implemented in close collaboration with the Council for Quality Assurance in Education (Umalusi), the provincial governments of Limpopo and North West, the national Department of Basic Education, the Department for Performance Monitoring and Evaluation in the Presidency, Statistics South Africa (StatsSA), and various other institutions which kindly made data available to the research team. The research team also thanks the various circuit managers, principals and teachers of the numerous schools in Limpopo and North West for their co-operation and for providing valuable inputs during the field visits.

This study was made possible thanks to the generous financial support of Anglo American Platinum's Community Engagement and Development business unit, and smaller contributions by Anglo American Chairman's Fund, First Rand Foundation and iBurst. The team is grateful to Prof. M Muller, Prof. I Abedian and Prof. A McLennan for their feedback and advice on content and methodology. Finally, this study was made possible by the hard work of research assistants, Khotso Tsotsotso and Mpho Nthlola, who provided support in the field work, data cleaning and editorial stages of the project.

ABBREVIATIONS AND ACRONYMS

BEE	black economic empowerment
CEA	cost-effectiveness analysis
CED	Community Engagement and Development
CSI	corporate social investments
DBE	Department of Basic Education
DID	difference-in-difference
EMIS	Education Management and Information Systems
FET	Further Education and Training
GIS	geographic information system
HDSA	historically disadvantaged South Africans
HOD	head of department
LTSM	Learning and Teaching Study Material
M&E	monitoring and evaluation
MEC	Member of the Executive Committee
MoU	memorandum of understanding
MST	maths, science and technology
NSC	National Senior Certificate
NGO	non-governmental organisation
PSM	propensity score matching
SLP	social and labour plans
SMD	standardised mean difference
SPSS	Statistics Package for the Social Sciences
StatsSA	Statistics South Africa
RBI	Royal Bafokeng Institute
RDD	regression discontinuity design
Umalusi	Council for Quality Assurance in Education
Wits	University of the Witwatersrand

ABSTRACT

Platinum mining is a major engine of South Africa's economy, producing exports and generating employment for many South Africans. It is, however, highly dependent on skilled labour, engineers and technicians, who are drawn from the limited pool of graduates emerging from the weak South African schooling system. Public-private partnerships have been established to address this gap. This study looks at the delivery, effectiveness and impact of the ZAR[1] 100 million (about $14 million) Anglo American Platinum education programme implemented in the Limpopo and North West provinces to improve learning outcomes in public schools, particularly in the critical subjects of maths and science. The study utilises a rich pool of data and combines qualitative, econometric, meta-analytical and quasi-experimental methods of evaluation, while engaging several institutions and stakeholders in the process. The research reveals some surprising findings with regard to the effects that mines have on learning results in surrounding schools and affected communities. The study re-affirms many current theories and raises new questions with regard to the role of educators, the impact of interventions, socio-economic factors, and other aspects affecting the school system. Moreover, the report illustrates some of the problems and shortfalls of development evaluation common practices. The findings provide useful inputs for the policies, programmes and investments of the government and corporate sector in addressing education and development challenges in South Africa.

CHAPTER 1

BACKGROUND

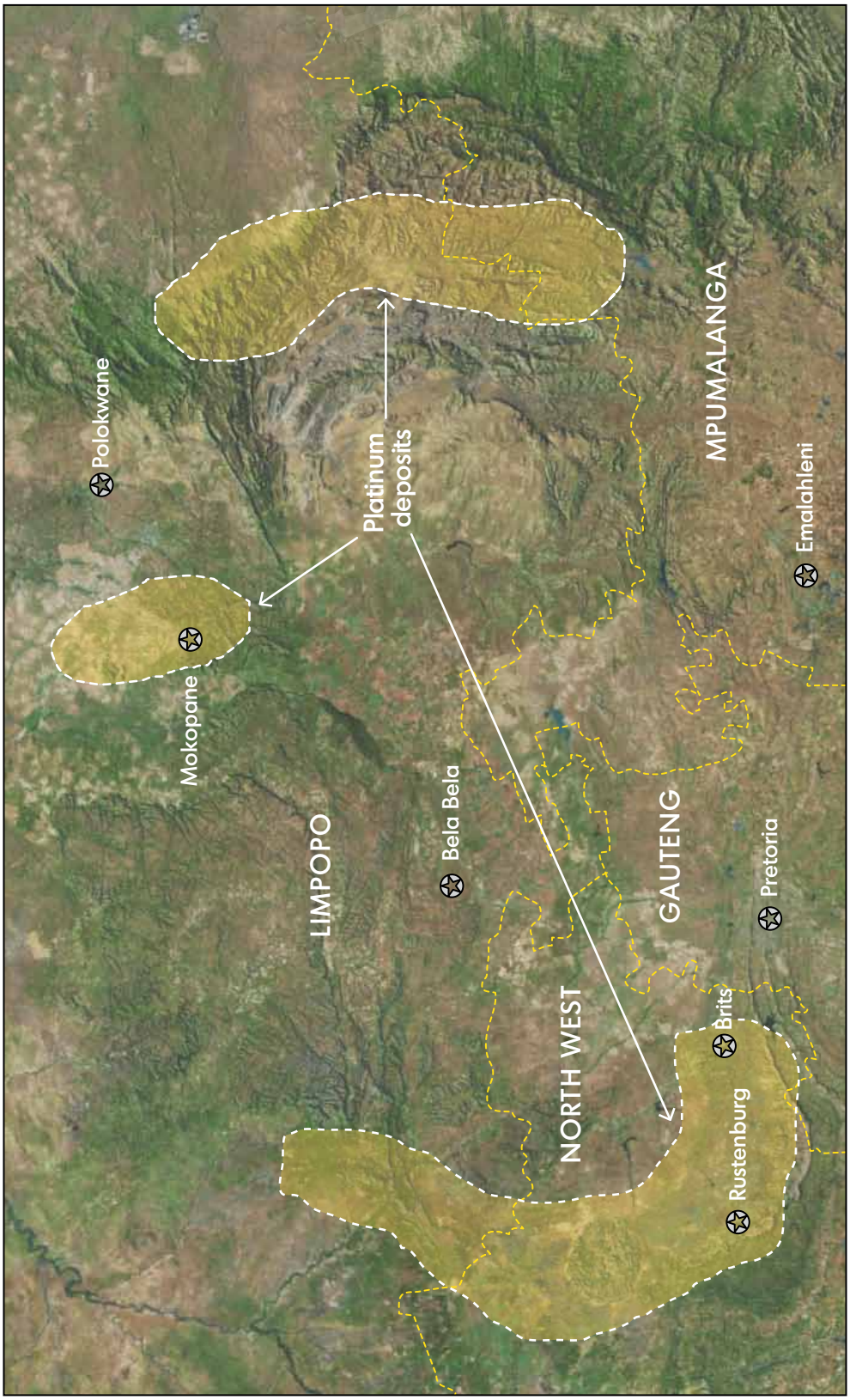
THE ROLE OF PLATINUM IN SOUTH AFRICA'S SOCIO-ECONOMIC DEVELOPMENT

Mining plays a central role in South Africa's history, economy and social structures. Migration to urban areas, the wide divide between capital and labour (mostly drawn on racial lines) and the extreme social inequalities that fuelled the apartheid system are intrinsically linked to the mining industry. Even the rise of the metropolis of Johannesburg and the township of Soweto took place on the back of the 'Witwatersrand Gold Rush' of the late 1800s. Although less dominant than in the previous century, the mining sector still generates up to 18% of the nation's gross domestic product. It also provides direct employment to over 500 000 people and indirect employment to another 1 million South Africans.[2]

South Africa has large deposits of numerous minerals, ranging from chromium, iron ore, diamonds, palladium and gold to coal, from which most of the country's energy is produced. However, since 1990 platinum has emerged as the largest component of South Africa's mining sector[3] with around 130 tonnes of output a year. This grew by 67% from 1994 to 2009.[4] South Africa holds 80 to 90% of the world's platinum reserves.[5]

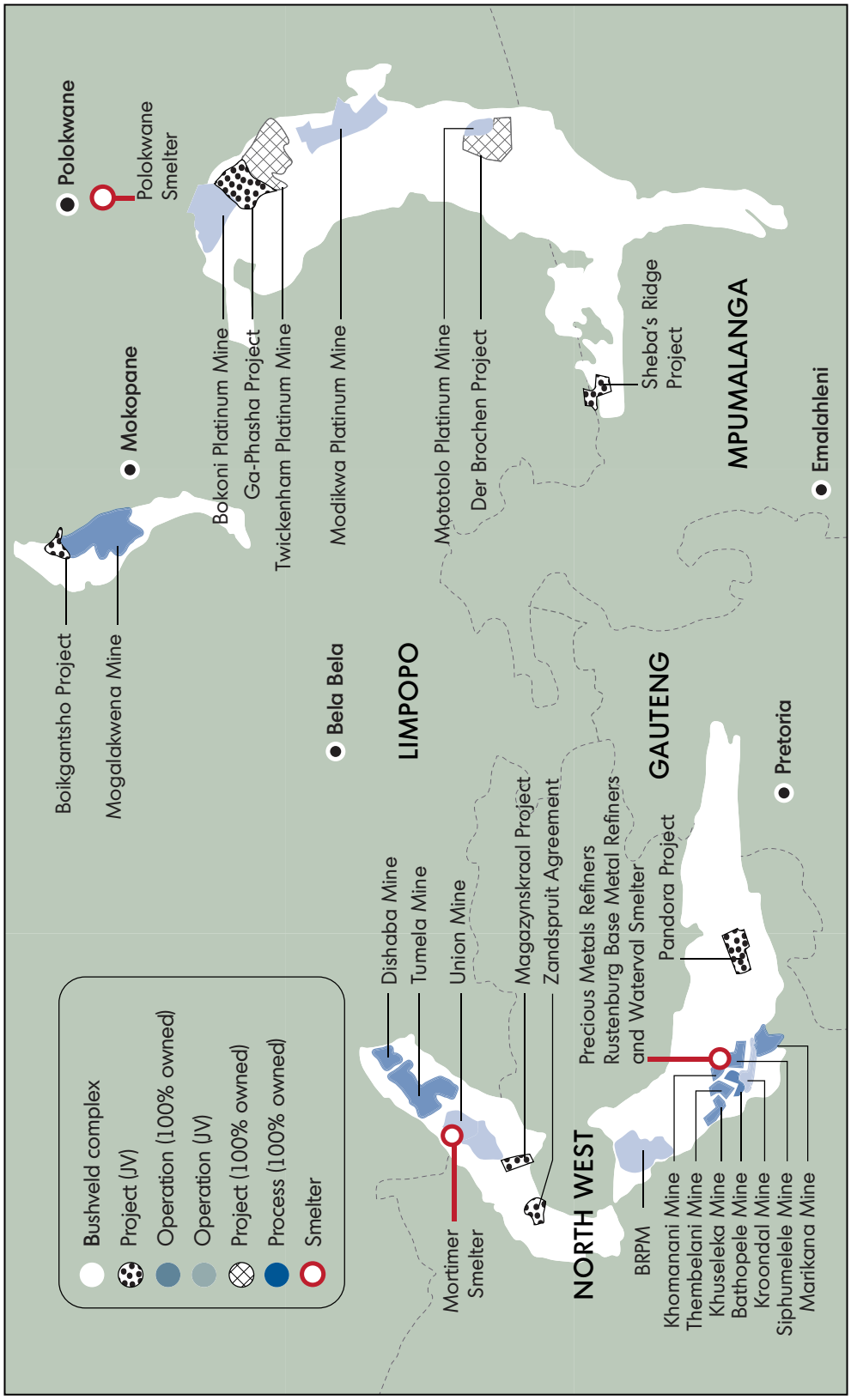
The Merensky Platinum Reef stretches from southern Zimbabwe, through Polokwane all the way to the Rustenburg region, with the largest concentration around the Bushveld Complex in the Bojanala district. Since the early 1900s this complex has attracted major platinum corporations such as Anglo American, Impala, Lonmin and Bafokeng Rasimone Mines. Another platinum-rich area is the Twickenham Reef in the Sekhukhune district, situated roughly 100 km south-east of Polokwane. The map in Figure 1 indicates the locations of some of the major platinum projects in the Limpopo and North West provinces.

Figure 1: Locations of platinum deposits in northern South Africa



Source: Author's own compilation; map data: Tom-Tom, 2013

Figure 2: Anglo American Platinum operations in northern South Africa



Source: Anglo Platinum, http://www.angloplatinum.com/sus/overview/operations.asp, 2013

South African platinum production is mainly geared towards international exports, which have been growing since early 2000,[6] driven by demand from the European automotive, medical and chemical industry[7] and by the growing Chinese jewellery manufacturing industry.[8] Nonetheless, due to the increasing cost of labour and electricity in South Africa[9] platinum prices have remained stagnant, with expansion projects put on hold and the potential threat of mine closures ever present. The labour situation badly deteriorated during the course of 2012 and 2013, with massive retrenchments, strikes, worker unrest, union fragmentation, violence and even murder leading to the 16 August 2012 'Marikana massacre', which made international headlines when 34 miners were killed in clashes with the police.

Like the rest of the mining industry, the platinum houses of South Africa are regulated by the Mineral and Petroleum Resources Development Act, which is aimed at minimising economic turbulence and natural resource depletion. The Act also makes provision for human resource issues such as employment equity, health, work safety and mine workers' living conditions. The Department of Mineral Resources grants licences and the rights to mineral exploration and production to private companies on certain socio-economic and environmental conditions (eg, black economic empowerment [BEE] requirements) that need to be fulfilled in and around mining operations.[10] An intrinsic part of these requirements is the development of social and labour plans (SLPs) detailing how the companies deal with human resources (employment equity, retrenchment, housing, skills development, etc.) and support the social, economic and infrastructure development of the communities around the mines. These SLPs are generally developed in a participatory manner through ethnographic techniques and by engaging the numerous local stakeholders (community groups, local government, traditional authorities, labour unions, NGOs and other civil groups) through consultative forums. SLPs are generally supposed to be aligned with the Integrated Development Plans of the specific localities.

Another impetus to aligning the mining sector with the country's transformation process was the introduction of the BEE policy by the Department of Trade and Industry,[11] aimed at transferring 25% of the country's productive assets to black ownership. BEE favours historically disadvantaged South Africans (HDSAs) in the areas of shareholding, management, staff, skills development and the procurement of sub-contractors. BEE compliance was a primary determinant in whether companies were granted conversion from the old to the new order rights under the Mineral and Petroleum Resources Development Act. Within the BEE framework, the Mining Charter (developed in 2004 and updated in 2010) also provides higher scorecards to companies that ensure sustainable environmental management, facilitate local beneficiation of commodities and resources, and support local community development activities.

The last decade saw the intensification of 'sustainability reports' by South Africa's private sector to highlight companies' contributions to the welfare of the country and relevant communities. This has resulted in major mining houses such as Anglo American Platinum, Kumba, Impala, De Beers and BHP Billiton spending over ZAR 100 million every year on corporate social investments (CSI).[12] Community investments by mining corporations in South Africa are implemented for a variety of reasons and motivations, including securing social licences, maintaining good relations with local stakeholders, improving BEE scorecards, marketing and enhancing public image, and genuine philanthropic efforts aimed at making a positive change in society. In recent years, CSI

approaches have also been more pragmatic, driven by 'enlightened self-interest', stemming from a realisation that having a healthy, educated, uplifted and prosperous local community is ultimately also good for business. By the same token, almost 92% of corporations in South Africa invest in education, because a knowledgeable and skilled population will enhance the workforce, clientele and quality of private sector service providers, and thus produce long-term returns for business. Overall, the local corporate sector's financing of South Africa's education sector surpasses by and large official development assistance from all the traditional bilateral and multilateral donors.[13] Just one company, such as Anglo American, spends more every year on social and education projects than the likes of the World Bank, the UN, the Japanese International Co-operation Agency, the Canadian International Development Agency, the United Kingdom's Department for International Development, and other foreign aid agencies operating in South Africa.

SNAPSHOT OF THE EDUCATION SECTOR IN LIMPOPO AND NORTH WEST

As discussed in previous papers,[14] the mining and service sectors (financial, logistical, telecommunications, retail) are the foundations of the South African economy. However, the country is not able to meet the high demand for engineers, financial analysts and technical specialists required by the key sectors to run the economy and allow for further growth. There are not enough young South Africans entering and completing university degrees in technical fields. This is mostly due to the poor performance of the South African secondary education system, which is not able to produce enough learners with the minimum competencies in maths and science. Roughly 4% of South African learners

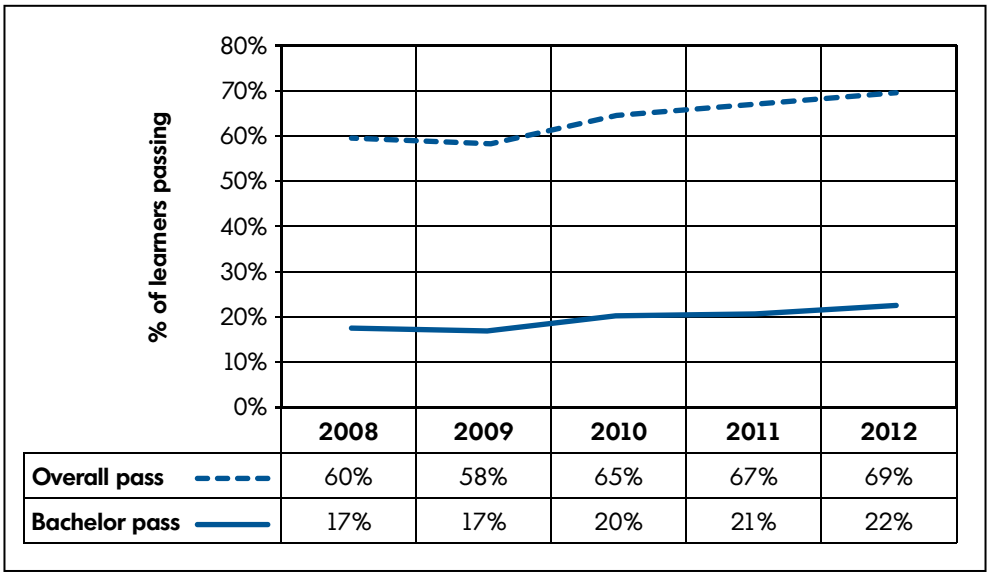
Grade 12 learners in Matsibe Secondary School, Limpopo, writing the 2013 NSC examination

who start grade 1 finish grade 12 with a pass rate above 40% in maths.[15] An older study[16] explained that of the total number of learners enrolling in grade 1 in the new post-1994 South African education dispensation, only 1.5% achieved a pass in higher grade (HG) maths during their 2006 grade 12 Senior Certificate (SC) exams. This poses a serious challenge for the mining industry, which needs to invest in education in order to increase and improve the labour pool of future technicians, artisans and engineers. Due to the national socio-economic transformation processes discussed earlier, it is imperative that mining companies pay special attention to sourcing future employees from their areas of operation, focusing on the black population and the indigenous communities affected by mining. Yet mining companies have reported that they struggle to award university scholarships and bursaries to youths from the communities around their operations.[17]

It would thus be appropriate to start looking at the academic performance of schools in the areas where the platinum mining operations occur, namely Limpopo and North West, particularly in the subject areas of maths and science.

The results from the National Senior Certificate (NSC) examination, undertaken at the end of grade 12 in all South African secondary schools, are potentially the best indicator to measure learner achievement and the progress of schools and regions. NSC exams are independently assessed by the central agency of Umalusi, using a universal system. Data is checked for quality and made available annually at micro level.

Figure 3: Overall and bachelor pass rates for NSC examination in South Africa



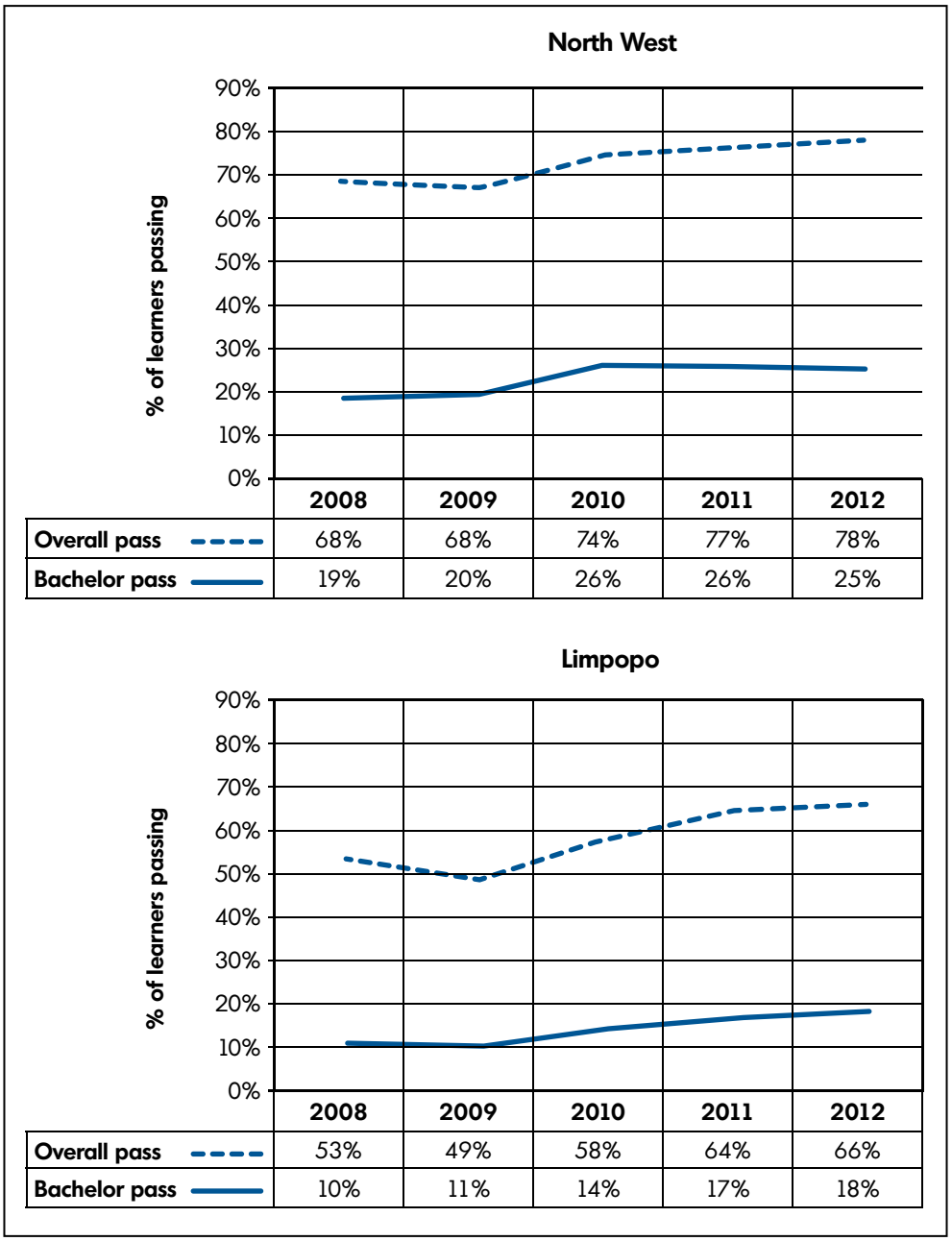
	2008	2009	2010	2011	2012
Overall pass	60%	58%	65%	67%	69%
Bachelor pass	17%	17%	20%	21%	22%

Source: Author's own compilation, 2013

The downfall of using the NSC examination results as the main indicator for progress in learning is that external interventions, schooling and social factors have less of an impact on older and formed pupils than on younger children. It is a well-documented fact in education and developmental literature that the greater percentage of learning gains occur at lower grades,[18] rather than at the end of the formal schooling process. Nevertheless,

the NSC provides a good indication of learner 'preparedness' for university and tertiary training in the commercial, technical and engineering subjects desperately needed by most businesses and the national economy. Aside from the overall NSC pass rates, of particular interest are the 'bachelor passes' that allow for university entry. As the NSC examination system changed between 2007 and 2008, the current graphs try to capture the progress in the overall and bachelor pass rates in the relevant regions from 2008 to 2012, in relationship to the overall country average.

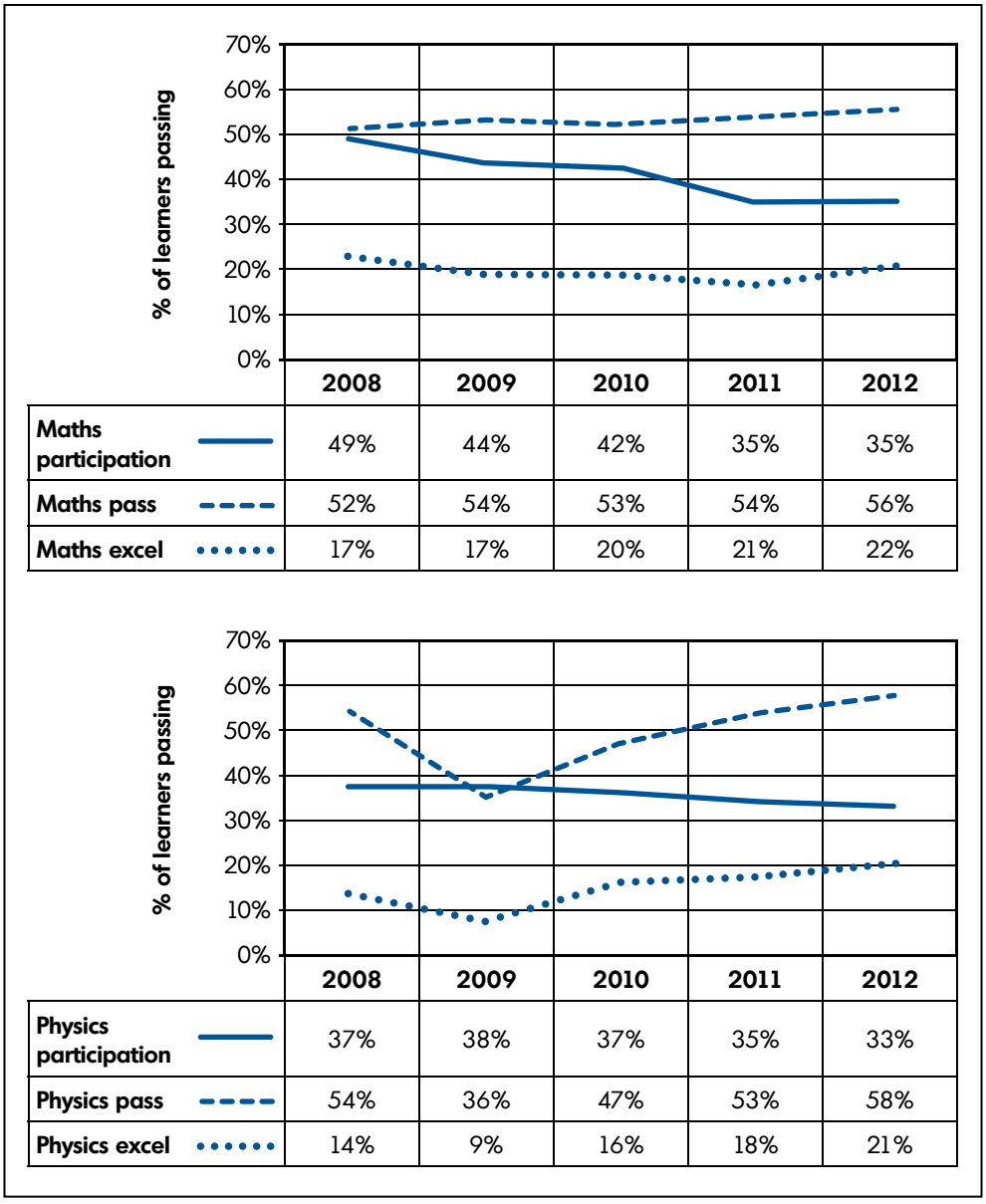
Figure 4: Overall and bachelor pass rates for NSC exam in North West and Limpopo



Source: Author's own compilation, 2013

Figure 4 shows that schools in North West tend to perform above the national average, while schools in Limpopo generally perform slightly below the national average, most likely due to the different socio-economic conditions in rural areas that differentiate these two provinces. Due to the presence of mining operations in the Bojanala district, North West receives a lot of attention and is the focus of various initiatives by public and private institutions. Limpopo manages three to four times more schools than North West and thus its limited educational resources are spread thinner.

Figure 5: Subject specific (maths & physics) pass rates for NSC exam in South Africa

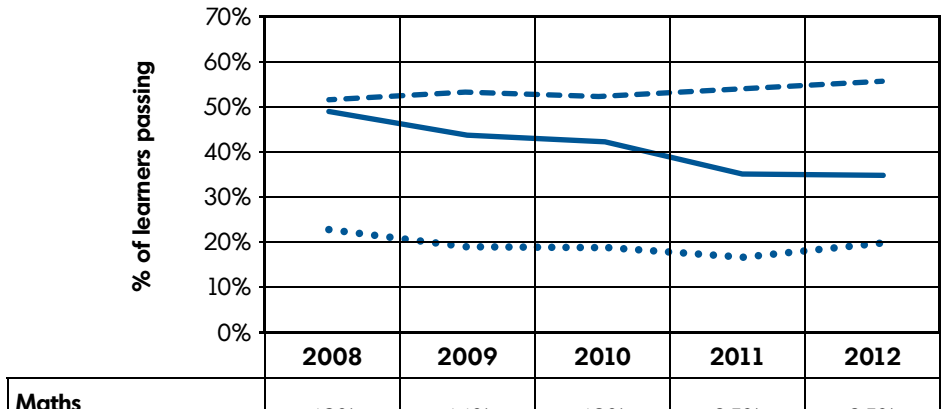


	2008	2009	2010	2011	2012
Maths participation	49%	44%	42%	35%	35%
Maths pass	52%	54%	53%	54%	56%
Maths excel	17%	17%	20%	21%	22%

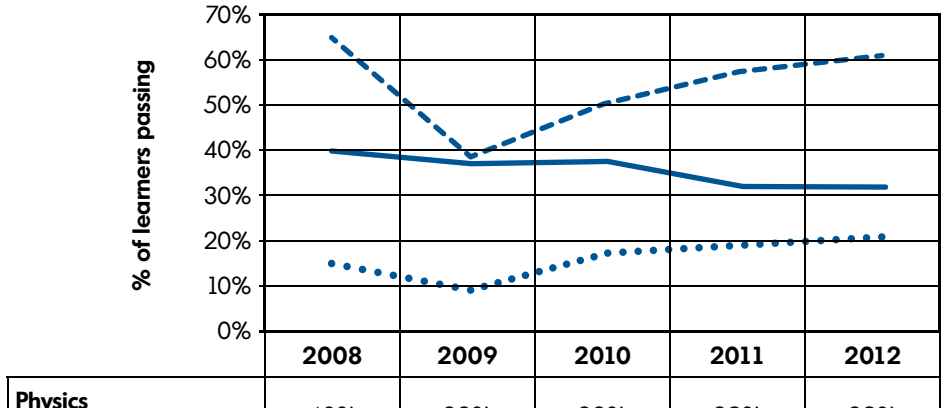
	2008	2009	2010	2011	2012
Physics participation	37%	38%	37%	35%	33%
Physics pass	54%	36%	47%	53%	58%
Physics excel	14%	9%	16%	18%	21%

Source: Author's own compilation, 2013

Figure 6: Subject specific (maths & physics) pass rates for NSC exam in North West



	2008	2009	2010	2011	2012
Maths participation	49%	44%	42%	35%	35%
Maths pass	52%	54%	53%	54%	56%
Maths excel	23%	20%	19%	17%	20%



	2008	2009	2010	2011	2012
Physics participation	40%	38%	38%	32%	32%
Physics pass	65%	39%	51%	57%	61%
Physics excel	15%	10%	17%	20%	21%

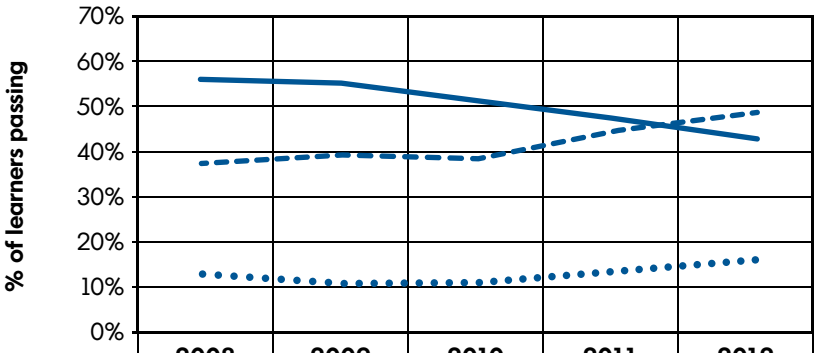
Source: Author's own compilation, 2013

Figures 5, 6 and 7 focus on the 'gateway subjects' of maths and the physical sciences, due to their importance to both the economy and the mining industry. Close attention will again be paid to the subject passes above 50% (excel), the minimum entry to university. However, studies[19] have shown how with the introduction of the new NSC system, grades above 60% in maths seem to predict more accurately satisfactory performances at university level for students in commercial and scientific subjects.

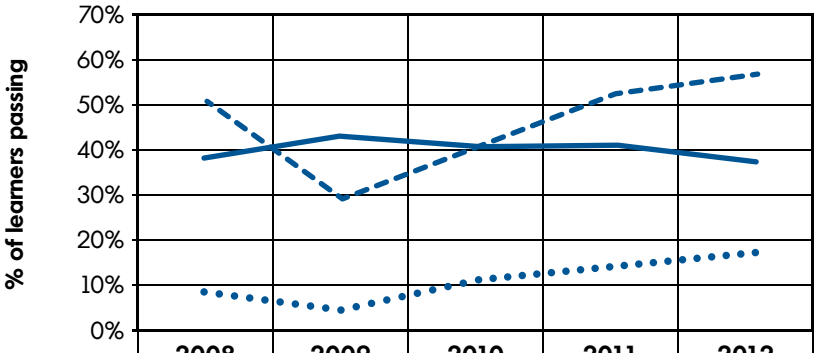
What might be surprising to international readers is that a minimum score of 30% is sufficient to pass the NSC grade 12 exams in the specific subject areas, highlighting the general poor quality of the South African education system. NSC pass rates are also

masked by the fact that many South African learners drop out of school before they write the exam. In public schools the number of grade 12 learners is on average half the number of grade 10 learners. In Figures 5, 6 and 7, maths and science participation relates to the percentage of learners writing the NSC who chose to take those specific subjects as part of their examination.

Figure 7: Subject specific (maths & physics) pass rates for NSC exam in Limpopo



	2008	2009	2010	2011	2012
Maths participation	56%	55%	51%	47%	43%
Maths pass	38%	39%	38%	44%	49%
Maths excel	13%	11%	11%	14%	16%



	2008	2009	2010	2011	2012
Physics participation	38%	43%	41%	41%	38%
Physics pass	50%	30%	40%	52%	57%
Physics excel	9%	5%	11%	15%	17%

Source: Author's own compilation, 2013

These graphs confirm trends that are familiar to some readers. Over the years there has been a gradual and expected increase in the general pass rates, as well as in the bachelor

passes. In early 2011 the Minister of Basic Education, Angie Motshekga, announced that despite the 'lost time' in 2010 due to the FIFA World Cup and the teacher and learner strikes that occurred that year, there had been a surprising spike in pass rates across the country. The big dip in the 2009 science passes was confirmed by Umalusi and explained by the fact that the exam's science paper was particularly difficult, resulting in a drop in science passes that year. There is an interesting correlation between the gradual reduction in the number of learners writing the maths and science exams and the increase in the pass rates in those subjects. This can be ascribed to stricter learner selectivity, a smaller teacher-to-learner ratio and the better spread of learning resources.

All of these are important general trends that need to be borne in mind when undertaking impact assessments of specific interventions that have been implemented in the two provinces to improve maths and science learning outcomes. This is to ensure that general social, economic and environmental trends do not confine or distort the results of the impact evaluation.

EDUCATION INTERVENTIONS BY ANGLO AMERICAN PLATINUM

Several big mining houses in South Africa undertake extensive CSI programmes in education, among which are Kumba, Impala, BHP Billiton, De Beers and Rio Tinto. However, this study will focus mainly on the education interventions of Anglo American Platinum in North West and Limpopo between 2009 and 2012. Anglo American Platinum is by far the largest platinum producer in South Africa, producing 40% of the world's platinum output and employing over 50 000 people every year. Previously known as Johannesburg Consolidated Investments and then Amplats before becoming Anglo American Platinum, the company has been undertaking education interventions since the 1990s, as revealed by a 1999 report by Eric Scholar and Associates evaluating its school development programme, which features are not drastically different to what it is today. Together with Kumba, Anglo American Platinum manages the largest corporate social investment budget in the Anglo American group. Within its Corporate Affairs division, the company established the Community Engagement and Development (CED) sub-unit, which deals with the mines' multiple stakeholders and develops, finances, implements and monitors socio-economic development programmes in local communities.

The current Anglo American Platinum education programming is based on its 2010–2014 SLP, which the company negotiated with the communities, local government authorities and other stakeholders affected by its mining operations in Magalakwena, Amandelbult, Union, Rustenburg, Twickenham and Der Brochen. These included local tribal groups in North West and Limpopo, such as the Bafokeng, Bengwenyama and Langa Mapela. Some of the labour-sending areas in the Eastern Cape such as OR Tambo District Municipality and the Taung community also form part of Anglo American Platinum's SLP. The community development activities to which Anglo American Platinum has committed itself are extensive and range from projects for health and welfare, poverty reduction, agricultural development and job creation to the establishment of basic community infrastructure. Within the SLP, education and skills development initiatives play a significant role. Shortly after finalising its SLP, Anglo American Platinum signed a memorandum of understanding (MoU) with North West and the Limpopo Department

of Education, through a North West Department of Education member of the executive committee (MEC) and the Limpopo head of department (HoD) of Education, in order to implement its whole school development programme. As the programme unfolded, Anglo American Platinum's local CED officials regularly liaised with district and circuit managers closer to the areas affected by the mines, and collaborated in the implementation of Anglo American Platinum's support activities to local schools.

A major part of Anglo American Platinum's infrastructure support has gone towards building or rehabilitating schools, extending classrooms and constructing administration blocks, toilets, and water and sewerage facilities for education centres close to the mining areas. This has included refurbishing libraries, outfitting science labs and donating computers, photocopiers and other equipment to schools and even circuit offices. During the past five years over ZAR 25 million (about $2.4 million) worth of infrastructure initiatives have been implemented in schools around the mines. Of greater interest, however, are Anglo American Platinum's education, skills development and youth-targeted initiatives, which have seen nearly ZAR 70 million (about $6.7 million) budgeted for the SLP timeframe. The company's education programme is extensive and covers many areas, including adult education and literacy (ABET), early childhood development, primary and general education training, special needs schools, bursaries for university students, apprenticeships, and technical and professional development for young professionals.

This study will focus on Anglo American Platinum's further education and training (FET) interventions in secondary schools, as it is easier to correlate development outcomes for beneficiaries with the results of the NSC examinations in the two provinces, for

Placard in front of Mahlogedi Secondary School in Limpopo, where Anglo American Platinum undertook renovations and infrastructure enhancements

which more reliable and detailed data is available. Some of the Anglo American Platinum interventions analysed are learner focused and some are educator focused, while others involve the provision of learning and teaching study materials (LTSM), or a combination of the above. Based on documentation and reports retrieved from the company and its service providers, a brief overview is provided of the major FET interventions Anglo American Platinum implemented between 2009 and 2012. Table 1 provides summaries of the projects' features, the costs and number of beneficiaries involved, the service providers responsible and the theory of change upon which these interventions were based.

Table 1: Anglo American Platinum's FET interventions to improve maths and science results

Supplementary Saturday classes	The Radical Math & Science company has been providing these classes since 2003 in the Rustenburg district, and in 2009 the classes were expanded to the operation areas of Atok, Polokwane, Mokopane and Swartklip. After an initial test and selection process, around 400 grade 10, 11 and 12 learners were selected to be part of the 'A team', which took additional classes in maths, physical sciences and business and social skills (including English). About 40 learners were grouped in each area of operation and met on Saturdays for half a day, receiving coaching, additional study guides and prizes for best performance. In 2010 the contract for the Saturday supplementary classes was given to the Star Schools NGO, which trained 600 grade 12 learners from all the operations in maths, science and English.
Winter enrichment camps	Special workshops were organised during the school holidays for over 900 learners from the schools around the various Anglo operations. The programme focused on maths, physical sciences, English and geography. Extra classes run by local educators normally lasted for five days, and were aimed at addressing some of the content gaps faced by learners due to the poor quality of teaching in their schools, and the difficulties they faced in covering the ambitious syllabus required for the grade 12 examination. The winter schools provided study guides, study materials and example questions from the exams, as well as pre- and post-assessments of the learners. These holiday camps were organised in 2011 and 2012 by Radical Math & Science, usually in three to five different venues across the two provinces, while accommodation, catering and transport were organised by the various mines.

Educator training	This consisted of a programme offered by the Centre for Research and Development in Mathematics, Science and Technology Education (Radmaste Centre) at the University of the Witwatersrand (Wits), involving a two-week workshop during the winter holidays for 60 teachers from 27 schools from across the Anglo operations. The course focused on content knowledge in maths, science and accounting to give educators more confidence in the subjects they were teaching. The workshop was hands on and interactive, and followed the official Department of Education curriculum. It was followed by a two-day follow-up session in September. The programme started in 2012 and was officially supposed to run for three years (up to 2014), but the initial plan was cut short due to the Marikana incident and the subsequent disruptions and financial crisis in the platinum industry. The programme was intended to give inadequately trained teachers supplementary in-service training from a reputable teacher-training tertiary institution.

Source: Author's own compilation, 2013

Aside from these major interventions implemented directly by Anglo American Platinum through private companies, NGOs and educational institutions, the company supported the flagship initiatives of the government by, for example, providing over ZAR 1 million ($140,000) in maths and science equipment to all the Dinaledi[20] schools of the North West.

Most of these interventions were well documented, with basic information available on the implementation of activities, including information on participants and the progress they made through pre- and post-learning assessments. As the evaluations were produced mostly by the service providers running the projects, assessments overall tend to be positive, subjective and more reliant on qualitative methods to judge achievement of activities and outputs. Programme logic and results frameworks are less explicitly illustrated in the reports, therefore leaving readers to infer the theory of change, which otherwise is fairly simple and straightforward for each of the above interventions.

Different schools benefitted from different projects (eg, teacher training, winter schools, infrastructure, etc.) by different service providers (Star Schools, Radical, Radmaste, etc.) and in different dosages (ie, number of learners and teachers participating). The research team endeavoured to gather as much information as possible through primary and secondary sources, consolidated all the activities and identified 137 schools in Limpopo and North West that received some kind of support from Anglo American Platinum over the last five years. In the following analysis these will be considered the 'Anglo-treatment schools', converted into a dummy variable of 'Anglo yes'.

CHAPTER 2

RESEARCH DESIGN AND METHODOLOGY

KEY QUESTIONS

Emerging from discussions with Anglo American Platinum, its service providers, other mining companies, education authorities and other stakeholders affected by the platinum mines, the following are some of the questions that guided the research team in their enquiry on the impact of the mining sector's education interventions.

- Were the education projects implemented according to plan? Were the beneficiaries and partners satisfied? Did the right stakeholders and groups benefit from the interventions?
- What impact did the presence of the mine have on schools in North West and Limpopo?
- Has the Anglo American Platinum education programme been effective in improving learning outcomes and pass rates (particularly maths and science) in the targeted schools?
- What can be improved in future education investments and how can greater impact be achieved?
- What important lessons can the mining industry and other corporate social investors learn from the successes and failures in addressing education gaps in South Africa?
- What have been the most successful interventions to improve learning results that should be replicated and scaled up? What provides the best value for money when addressing education outcomes in South Africa?

These questions were investigated from the standpoint of an independent evaluation team from Wits University that did not have any particular stake in the outcome of the study. As most interventions have already occurred, the evaluation was ex-post and used rigorous scientific and empirical methods of enquiry. The study was the first to pilot[21] an evaluation model and methodology framework, which consisted of a combination of participatory mixed methods, theory-based quasi-experimental impact evaluations, cost-effectiveness analysis and meta-analytical techniques. The purpose was to inform government and corporate strategic planning, improve education policies and systems, and guide future investments.

QUALITATIVE FIELD VISITS AND LOCAL INFORMANTS

The methodological framework used for this study[22] relies heavily on quantitative approaches such as quasi-experimental evaluation. Nevertheless, the research team

decided to begin the enquiry by integrating classical field visits, although this was not as rigorous and systematic as a full-fledged qualitative study. However, it was important to better understand the context, identify the various interventions implemented, unpack the theories of change, analyse the factors influencing outcomes, and uncover insights and information that would otherwise be difficult to gauge from a purely quantitative analysis and desktop review.

The study began with two months (October and November 2013) of intense field immersion in Limpopo and North West to the sites and schools around the platinum mining operations. This involved the direct observation of a sample of 22 schools that received significant support from Anglo American Platinum in Rustenburg, Moses Kotane East, Thabazimbi, Leboagomo, Mokopane, Sekukune and other areas. The school visits, interactions with stakeholders and contextual analyses were enriched by the fact that the evaluation team consisted of individuals of different local and international cultural and linguistic backgrounds, which provided fresh perspectives on the issues being observed.

During the field visits, semi-structured interviews and focus group discussions were held with numerous stakeholders involved in maths and science interventions in secondary schools in Limpopo and North West. These would typically consist of informal conversations between the Wits–SAIIA research team and school principals, maths and science educators, curriculum advisors, circuit managers and district managers. The team tried to keep discussions relaxed, informal and non-threatening by ensuring confidentiality under the 'Chatham House Rule'[23] and by not utilising recording devices. Conversations with local education authorities and school management were usually guided by open questions, such as those listed below.

- What are the factors that have had the biggest influence and impact on improved learning results in your school/area?
- What interventions (by government, NGOs, donors and private companies) have occurred in your area/school to improve maths and science results? What was the theory behind these programmes?
- Have you received support from mining companies over the last five years? What kind of assistance? How have these programmes been implemented? Have you been satisfied with the results? Any feedback?
- What are the most pressing needs and most important aspects in the current education system that need to be addressed in order to improve learning outcomes?
- What are the recommendations you have for mining companies on how they can improve their programmes and make best use of their resources to increase maths and science pass rates in your school/area?

The stakeholders with whom the research team interacted during the field trips in Limpopo and North West are listed in Appendix 1. These include interviews in Gauteng with national education authorities and managers of service providers implementing maths and science programmes in the two provinces of interest. Shaded stakeholders refer to the schools that received an on-site visit.

Research assistant Khotso Tsotsotso (middle) with a circuit manager and three school principals in Mokgodumo, Limpopo

DATA PREPARATION

Considering the complex impact evaluation methods used in the study, large datasets had to be compiled that combined data gathered by different institutions and from diverse sources. Some of the data that needed to be merged included

- intervention information;
- NSC (matric) exam results; and
- school administrative, social & economic data.

The main units of analysis were 'schools', therefore all the datasets had to be merged using the official school Education Management and Information Systems (EMIS) number (a unique code used by the Department of Education to identify schools). This resulted in an initial mega dataset with a total population of 1 412 schools in Limpopo and 385 schools in North West with which to conduct the subsequent statistical analysis.

Traditionally, in South Africa especially, a lot of the econometric and experimental work in this genre is done by economists using Stata software. However, as the research team consisted mainly of social scientists, the group chose to use the Statistics Package for the Social Sciences (SPSS), which has a more user-friendly interface and does not require much time to learn a whole new coding language. In order to accommodate some of the more complex statistical analysis, such as propensity score matching, R plugins were downloaded. In the process of managing and cleaning the data, software such as Excel and Access was also used, especially when receiving data from Umalusi and the Department of Education, but eventually these were all merged and converted into SPSS data files.

Confounding interventions

Programme and project information included the type of activities, the beneficiary schools, locations, time periods and implementation costs. This has been provided by Anglo American Platinum and its service providers, as well as other organisations (government, NGOs and private sector) implementing programmes to improve maths and science in secondary schools. This information was extracted either from official reports or through interviews with relevant officials.

The primary interventions under analysis are the Anglo American Platinum education programmes implemented between 2009 and 2012. However, during this time frame many other interventions occurred in Limpopo and North West to address the same outcome of improving maths and science learning results in secondary schools. Although the scope and resources of this study would not permit doing an impact evaluation on each and every one of these programmes, the research team felt that it was important to be aware of them and be able to control for these potentially confounding interventions in the statistical analysis so as to isolate the effects of the Anglo American Platinum programme from the effects of other interventions. Through the fieldwork in the two provinces and interviews with school and education authorities, the research team was able to identify some of the major interventions implemented to improve maths and science in secondary schools (see Appendix 2).

While there certainly may be more maths and science interventions in North West and Limpopo than the list contains, this is the extent to which the research team was able to investigate through literature review and interactions with the relevant schools and education authorities. Some of the bigger and more interesting interventions require their own separate impact evaluation in the future, allowing for additional time, resources and data.

These initiatives by various institutions might also have had an effect on the maths and science results of the schools in the region, therefore the research team tried to control for them during the statistical analysis and impact evaluation of the Anglo American Platinum programme. When data was made available for external interventions, especially with the specific schools affected, these interventions were turned into binary dummy variables. A further dummy variable (ANY_intervention_Yes) was created indicating whether the school received any intervention from any institution between 2008 and 2012.

Outcome data: NSC results

As discussed earlier, the main outcome indicator used to measure schools' progress was the NSC grade 12 exam results. Thanks to its close collaboration with Umalusi, the research team was able to get detailed and accurate data for all the schools in Limpopo and North West from 2008 to 2012. This included the number of learners who wrote the exam, the overall pass rates and the quality of the pass rates in the specific subjects of maths and physical sciences. Data on English (first additional language) passes was also observed, as this is believed to correlate with the overall results and performance in scientific subjects. Initially data was provided on the exact number of learners who wrote and passed the exams with different marks, but this was later converted into percentages for more appropriate and fair comparisons between schools of different sizes. Appendix 3

shows the intervention variables that were created by the research team for all the schools in North West and Limpopo.

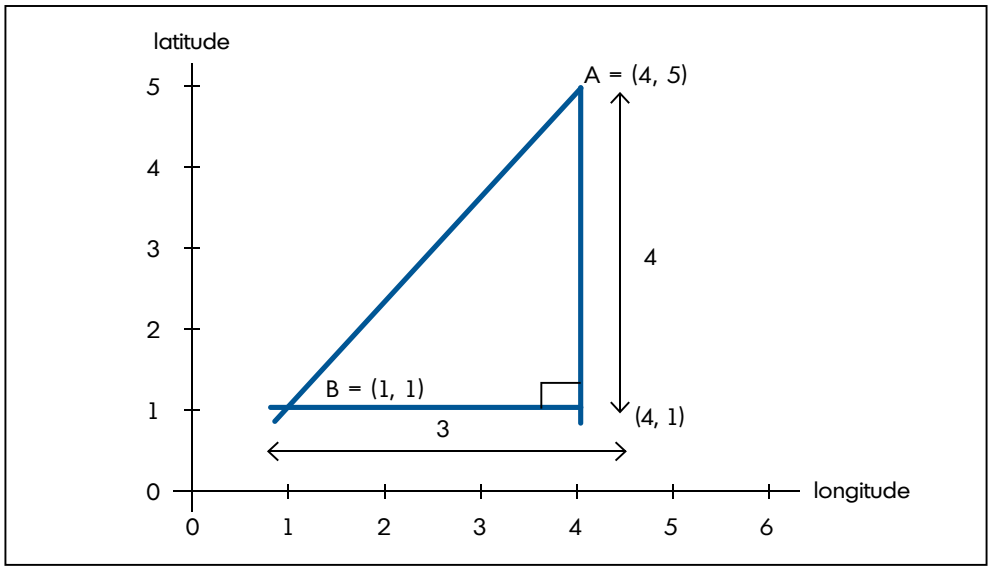
School administrative and demographic data

In order to undertake some of the econometric and complex matching operations and have enough control variables (covariates) for the impact evaluation (see the following sections), it was important to gather as much information as possible about each of the schools in the dataset, including demographic, social and economic data, resource availability, characteristics of learners and educators, management and other aspects. This was gathered primarily through EMIS. Some data was also sourced through StatsSA and the provincial EMIS offices. The EMIS data used was taken from the Annual School Surveys. Since the information changed over the years, the EMIS data from 2010 was used as a mid-reference point for when interventions were implemented.

The team was also cautioned that the EMIS data was not always accurate and reliable, as schools sometimes under- or over-reported due to education funding and resource allocation often being linked to school characteristics. This raised the risk of misspecification errors. If the researchers were not sure about the usefulness or accuracy of the data, such variables were often taken out of the analysis. In many instances the research team had to cross-reference, check and undertake additional calculations, transformations and re-coding of some of the variables during the data cleaning process. Whenever possible, absolute numbers were converted into percentages (eg, of total learners or teachers) in order to have a more useful variable with which to compare schools of different sizes and to make the results easier to understand by the common reader. The research team finally generated a mega-dataset of over 100 intervention, outcome and school characteristics variables (as shown in Appendices 3, 4 and 5) for each of the nearly 1 800 schools in the population of secondary schools in North West and Limpopo used in the study.

From the field research it was evident that the school's location could have a significant impact on learning results, as each area received attention and support from different external institutions, while each circuit and district education office also had different officials with different levels of commitment and enthusiasm for new initiatives, which could push results up. As the urban/rural data did not prove to be complete and accurate, the other option was to convert the categorical variables of the locations into numerical values. As the circuits were far too many and the provinces only two, the research team decided to convert into dummy variables all 23 district municipalities, with each containing between 10 (Kagisano Malopo in North West) and 233 schools (Capricorn in Limpopo).

Figure 8: Calculating proximity to mining operations



Source: Author's own compilation, 2013

Another geographic factor discovered to have an impact on schools (see section on findings) was their proximity to mining operations. In order to calculate the distance (km) between schools and mines, and subsequently construct the dummy variable '50 km from mines', the geographic information system (GIS) co-ordinates (latitude/longitude) of each school and platinum mine were gathered and a basic formula of trigonometry was applied. Assuming a flat surface, a straightforward Pythagoras theorem could be used to calculate the distance (d) between the mines (m) and the schools (s) as in:

$$d = \sqrt{(Lat_m - Lat_s)^2 + (Lon_m - Lat_s)^2}$$

However, the surface of the earth is spherical and when calculating distances above 17 km, the Pythagoras formula becomes inaccurate and causes errors. A more precise way to calculate the distance between the schools and platinum mines in North West and Limpopo is through the Harversin formula:

$$d = 2r \arcsin\left(\sqrt{\text{haversin}(\varnothing_2 - \varnothing_1) + \cos(\varnothing_1)\cos(\varnothing_2)\,\text{haversin}(\lambda_2 - \lambda_1)}\right)$$

where

$$\text{haversin}(\theta) = \sin^2\left(\frac{\theta}{2}\right) = \frac{1 - \cos(\theta)}{2}$$

d is the distance between the two points (along a great circle of the sphere; see spherical distance);
r is the radius of the sphere;
$\varnothing_1$, $\varnothing_2$ latitude of point 1 and latitude of point 2; and
λ_1 , λ_2 longitude of point 1 and longitude of point 2.

Final data cleaning and rendering

To conduct econometric analysis on the data gathered from the various institutions, most of the variables needed to be converted into numerical values. Some were made into binary dummy variables, some into scale (absolute numbers and percentages), and others ordinary (such as the variables for school quintile and school specialisation).

In order to use some of the more sophisticated statistical techniques such as propensity score matching (discussed in the next section), it was important that the dataset did not have any missing or incomplete values. There was a lot of missing data in the original datasets provided by the various institutions, so the research team had to take decisions on how to treat the missing data. For many of the variables such as information about the infrastructure, resources, curriculum, language and socio-economic status of schools and learners, the team was able to estimate the missing values by using the mode (majority value) of the cases, the mean (average), or the value that appeared most logical based on theory and fieldwork. In the event where there were too many cases of missing data that could not be estimated and the variable did not seem to have a major impact on results (such as with the variables of former Bantustan[24] schools, the percentage of educators with academic degrees, the urban/rural location, repeaters and drop-outs), the team decided to omit these variables from the matching process. If there were only a few missing and problematic values (such as with some of the NSC results), the analysts decided to delete the specific cases from the dataset, as long as this did not affect the schools receiving interventions (which were important for the evaluation).

Finally, the dataset was checked for any outliers and anomalous cases and corrections were made accordingly. By the end of the data cleaning process, the total number of secondary schools from Limpopo and North West included in the analysis was reduced from 1 796 to 1 536, and the total number of Anglo-supported schools was reduced from 137 to 134. Both the treatment sample and the population sample from which to extract the control groups were large enough to arrive at statistically significant results during the next stages of the impact evaluation.

IMPACT EVALUATION TECHNIQUES

Once the dataset for the complete population of schools in North West and Limpopo was prepared and cleaned, the team was ready to conduct the statistical analysis required to measure the impact of the maths and science interventions. As the evaluation taking place is ex-post and a randomised experiment was never planned at the start of the interventions, the research team had to rely on quasi-experimental methods, which were cheaper but required access to a lot of administrative data, which luckily was available. The use of unobstructive ex-post analytical methods also prevented the study from unwarranted 'Hawthorne effect'[25] and 'John Henry effect'[26], which could have occurred in the control and programme group if a real-life experiment had been set up. Below are the techniques used during the quantitative analysis based on the evaluation model and methodological approach presented in previous papers.[27]

Regression analysis

Econometric non-experimental approaches are often used to measure interventions' impact. However, these are usually not very precise, as they are based only on observable variables. In this case, one can never fully control for extraneous variables, which can have significant confounding effects.

Experimental and quasi-experimental approaches are preferred over regression approaches for the purpose of calculating net impact. Nevertheless, running a regression with the variables available is a useful first step to have some idea of which factors and interventions could be more closely associated with the outcome (y) variable and how strong these correlations are. This said, before the experimental work was conducted the group ran a simple linear step-wise regression using the list of independent variables (provided in Appendices 3, 4 and 5), avoiding potential issues of duplication and multi-collinearity. The main purpose of running a regression was to have a rough indication of the connection between the different independent variables and the pass rates. Of particular interest were the beta coefficients and the significance levels of their respective probability values (p-value). Four regression models were run using the following variables as the dependent (y) variables:

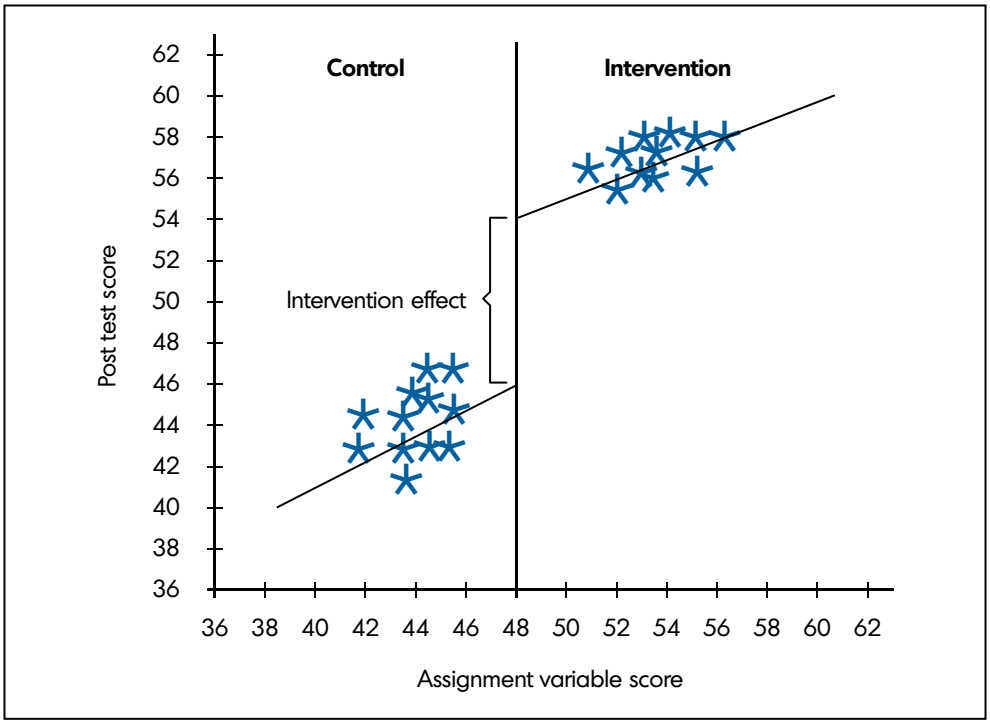
- NSC maths passes (above 30%);
- NSC maths excel (above 50%);
- NSC physical science passes (above 30%); and
- NSC physical science excel (above 50%).

This regression and correlation analysis was a useful first step to assess which variables from the long list of interventions and administrative, socio-economic and demographic variables had more influence on the outcome, so that these could be prioritised and used as covariates during the propensity score matching.

Quasi-experimental design

In the absence of a randomised control trial, one of the strongest quasi-experimental techniques used in impact evaluation is regression discontinuity design, sometimes known as cut-off point design.[28] This is often used when participants in a programme have been selected on the bases of a clear score (cut-off point) on a scale, such as performance (measured by pass rates or test scores) or poverty (measured, for example, by quintile or income level). The theory assumes that the group of individuals in the programme who are just below the cut-off point is not much different from the group of individuals just above the cut-off point who didn't enter the programme. Their participation was thus almost by chance (quasi-random), therefore producing a fairly strong and valid counterfactual. This assumes that there was also no spillover or attrition over time between programme and control groups and that those samples were large enough to check to ensure that they were statistically similar.

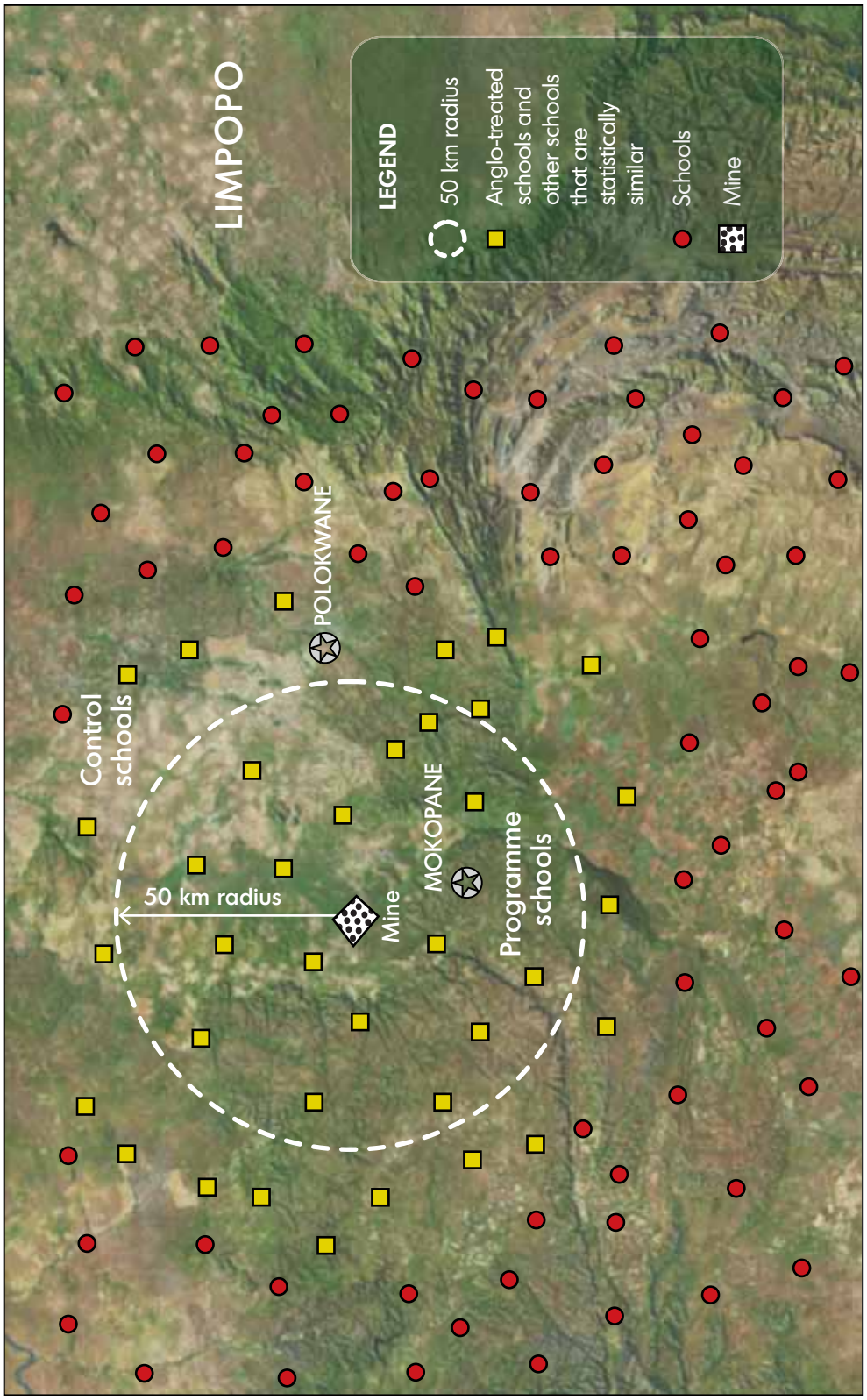
Figure 9: Graphical representation of a regression discontinuity design evaluation



Source: Author's own compilation, 2013

Considering the particular nature of the study involving mines and affected communities, the research team decided to experiment with the same cut-off point design technique, but applied to a continuous scale of geographical distances (km). One of the variables calculated by the analysts using the GIS co-ordinates was the distance from the schools to the mine. According to mining legislation, as well as the CED strategy of Anglo American Platinum, the communities (and therefore the schools) that should receive support and compensation from the mine are the ones within a 50 km radius. If this selection of participants in the Anglo education programme was applied strictly and there was no spillover between the programme and control group, we could use the cut-off point design technique. This would imply an imaginary geographic circle with a 50 km radius around the mine, where the schools that are part of the intervention and close to the border of the circumference are theoretically very similar to the schools that are just outside the circumference and did not get into the programme. Thus we would have a good experimental sample and control sample.

Figure 10: Example of application of regression discontinuity design to geographic scale within mining context

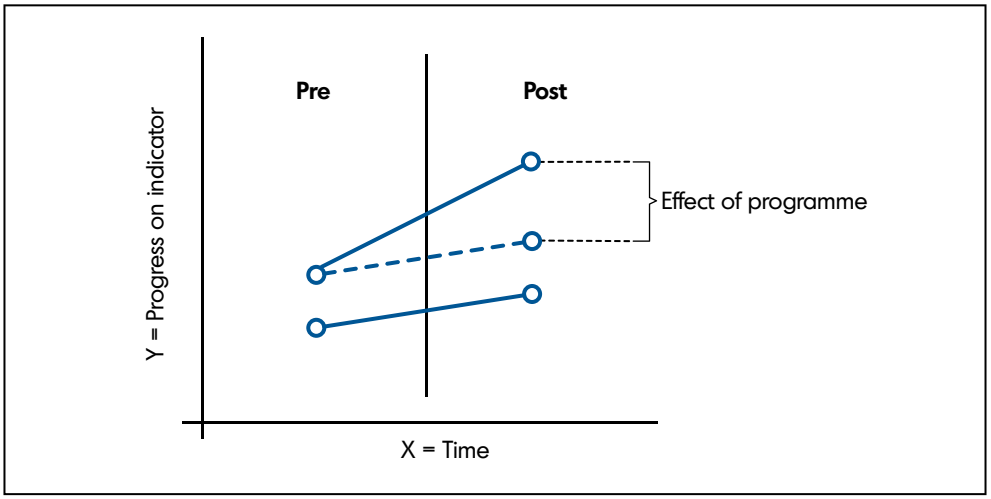


Source: Author's own compilation; map data: Tom-Tom, 2013

Another quasi-experimental technique used in this impact evaluation was propensity score matching (PSM). This is a popular technique also used in the past in South Africa's education sector to measure the impact of the Dinaledi schools.[29] The method is often used in ex-post evaluations where a lot of data is available, such as in this situation. The basic concept behind PSM is to artificially develop a control group that is statistically similar to the programme group (which has already received the treatment). This is done by matching/pairing schools that have received the treatment with one or more schools in the bigger population based on various characteristics and variables that make up a composite 'propensity score' upon which groups can be compared.[30] As the study subjects are schools, they have been matched based on characteristics such as quintile, resources, teachers and learners (see full list in Appendix 5). By the end of the PSM process, the artificial control group generated by SPSS is on average and with the combination of all covariates statistically similar to the programme group in at least all the observable and measurable variables. The groups should be almost identical except for the fact that one received the treatment (Anglo programme) and the other did not.

PSM tries to construct a control group based on observable variables, but there are always other unknown factors that can cause one group to perform better than the other. One way to address the unobservable difference is to incorporate the difference-in-difference (DID) method in the evaluation model. The a priori assumption of the DID method is that even though the control and programme groups may differ, they are affected by the same unknown external factors and therefore their progress and trends should be at least on the same trajectory.[31] Therefore, by observing the difference in the post-test between where the treatment group is and should have been, one can infer the net impact of the programme.

Figure 11: Calculating the effect of the programme through DID method (taking into account pre-existing difference between treatment and control and general time trend)



Source: Author's own compilation, 2013

To observe the impact of a programme, one need simply compare the difference between the post-test of the treatment and control groups with the difference between the pre-test of the two groups:

$$Raw\ Effect = (O_{t2} - O_{c2}) - (O_{t1} - O_{c1})$$

Algebraically speaking, the same result should be reached by comparing the difference between the post-test and pre-test of the programme group with the difference between the post-test and pre-test of the control group, simply by re-arranging the equation:

$$Raw\ Effect = (O_{t2} - O_{t1}) - (O_{c2} - O_{c1})$$

Normally there will always be a difference between the control and the treatment groups. It is therefore important to check if that difference is statistically significant by analysing results from all the cases within the two samples. An independent group student t-test would provide a more accurate indication of whether the intervention had a significant effect on the treatment sample compared to the counterfactual group. The results of the t-test are highly sensitive to sample size; therefore it is critical that the largest possible sample sizes are constructed to allow for comparisons between the programme and control groups. Although we cannot make inferential conclusions about the results obtained from the t-test since the fundamental requirement of random sampling is questionable, the estimates from the t-test summary will be used in calculating the effect size, explained below.

Measuring effectiveness

A t-test would reveal if the intervention had a significant impact (whether positive or negative) on the beneficiaries, but it would not be able to quantify the exact extent of that effect. Using the regression coefficient or the raw result of the DID would also not be an accurate way to measure the net impact of the treatment. The sample size and standard deviation of the mean also play a very important role in estimating the impact of the intervention with more precision. A more appropriate way to measure the impact of a programme is by calculating its 'effect size'. One of the most popular ways of calculating effect size used in meta-analysis is the standardised mean difference (SMD), also known as 'd',[32] which requires information such as sample size,[33] and the mean and standard deviation of both control and programme groups, in a formula that reads:

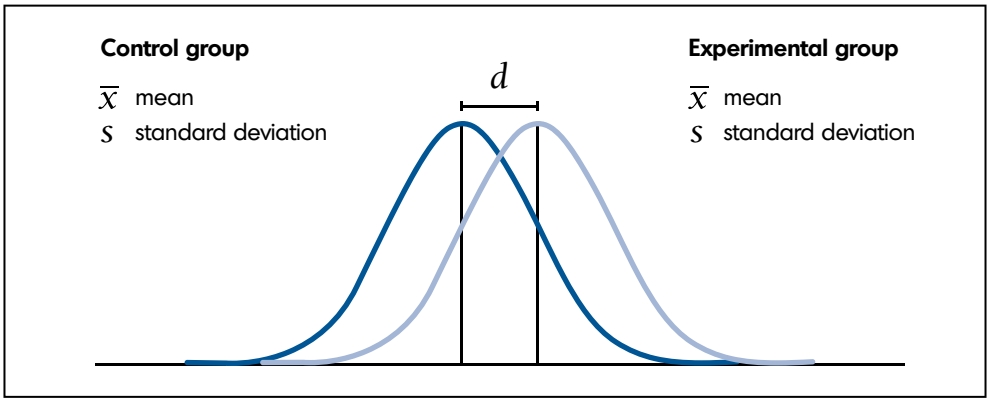
$$d = \frac{\overline{x}_1 - \overline{x}_2}{S_{pooled}}$$

where

$$S_{pooled} = \sqrt{\frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}}$$

Much of this information, including the confidence intervals (generally at 90% or 95%), can be extracted from the t-test produced in SPSS. Figure 12 offers a graphical example of the distribution of a control and programme sample. The difference between the mean and standard deviations of the two groups gives an indication of the effect size (d).

Figure 12: Graphical representation of effect size



Source: Author's own compilation

Instead of doing the calculations manually, Lipsey, Wilson[34] and others provide useful effect size calculators.[35] In this study the impact of the mining companies' education programmes will be assessed against eight selected outcomes of interest:

- maths enrolments;
- maths passes (above 30%);
- maths excel (above 50%);
- physics enrolments;
- physics passes (above 30%);
- physics excel (above 50%);
- overall passes; and
- bachelor passes.

However, once the effect size of the interventions on each of the outcomes is calculated, how do we know if the impact is substantial or not? The meta-analytical literature[36] provides a rough indication of how to compare the effects of different treatments and interventions in the social sciences. Once the effect size of a programme is calculated, the following 'rule of thumb' on the magnitude of 'd' (see Table 2) could apply when judging the effect of an interventon.

Table 2: Indicative table on magnitude of effect sizes

Cohen's d (1988)	Lipsey's d (1990)	Interpretation
0,2	0,15	Small effect
0,4	0,45	Medium effect
0,8	0,90	Large effect

Source: Lipsey MW *et al.*, *Translating the Statistical Representation of the Effects of Education Interventions into More Readily Interpretable Forms (NCSER 2013-3000)*. Washington DC: National Center for Special Education Research, Institute of Education Sciences, US Department of Education, http://ies.ed.gov/ncser/

As a word of caution, however, these tables should not be taken strictly as effect size can vary greatly depending on context, population, intervention, sample size, outcome and the measurement instrument being used. The sizes of d can also vary from sector to sector. In the education field, for example, the impact of most interventions on improved learner achievement tend to be small[37] and even a programme that produces an effect size of 0,25 is worth taking into consideration in the policy space. Hattie,[38] on the other hand, would argue that most interventions in education produce an effect and that the natural tendency is for learners to improve anyway, therefore the interventions that should be given more attention are the ones with an effect size above 0,40. Lipsey[39] highlighted the importance of using broad measures such as state test scores (for example, the NSC exam results) to measure impact more accurately, while expecting most effect sizes measured at school level to provide values of approximately 0,10, which will be significantly lower than when measuring results at classroom, group or individual level.

CHAPTER 3

EVALUATION FINDINGS

The following sections will present the results from the qualitative, econometric and quasi-experimental work conducted in this evaluation. The findings from the qualitative fieldwork will be illustrated first, as these affect the variables that have been chosen for the subsequent quantitative analysis. The qualitative findings also help explain and validate some of the theories that emerged from the results of the regression and experimental work that occurred as part of this research.

RESULTS FROM QUALITATIVE ASSESSMENT

As discussed in the section on qualitative field visits and local informants, the more empirical side of the evaluation lies in the quantitative analysis, and therefore the feedback below should be considered within the bounds of subjectivity and the opinions of the individuals with whom the team engaged during the field visits. Nonetheless, the qualitative work was still very useful to explain more vividly the background and local context, and shed more light on what emerged later through the quantitative results, which will be presented in the subsequent section.

This initial section highlights some of the findings from the fieldwork. It represents the synthesis of the majority views and inputs gathered from the interactions with the local stakeholders, through interviews and focus group discussions conducted by the two independent analysts. Some quotes and verbatim statements from school principals and local education authorities have also been shared. The feedback and insights from the qualitative work have been grouped into six main emerging themes, presented below.

Selection issues

One of the key elements is the way in which the beneficiaries of the Anglo American Platinum education programme were selected and chosen. This process had an inevitable effect on the overall impact of the interventions, as well as on how the evaluation of the programme was conducted. Due to limited resources, the Anglo programme could not accommodate all the communities in Limpopo and North West, and therefore a selection process had to be undertaken in one way or another.

The first level of selection that occurred was at the school level. According to Anglo's official CED policy, the first communities to receive support from the company are the ones located within a 50 km radius of the mine. This implies that certain areas (Rustenburg, Mokopane, Thabazimbi, Sekhukune, etc.) and certain tribal groups (ie, Bafokeng, Bengwenyama, Langa Mapela) that are situated closest to the mines benefit the most from the mining companies' social investments. This policy is obviously criticised by those schools and communities located farther away from the mine. Whatever the

fairness of this policy, it is true that those communities and schools closest to the mines are also the ones that suffer the most from the negative externalities of mining operations.

The next level of selection occurred at the level of individual participants from the short-listed schools. Aside from a few teacher-training interventions, the majority of education programmes focused on learners. This presented a problem, as resources were limited and the service providers could only accommodate a small group of learners in their programmes. In the words of one school principal, the interventions were 'just a drop in a big ocean' and therefore played a marginal role in affecting overall pass rates within the broader school system. Once the selected learners passed grade 12, there would be more learners with the same problems, and everyone would be back to square one. Education stakeholders in the two provinces have stated that it would be better to assist all of the learners and not just the 'lucky few'.

However, this utilitarian argument can also be contested, as others will argue that once the intervention is diffused within the broader population it becomes less effective and more difficult to perceive its impact. From a practical perspective, one can also argue that in a situation with limited funds it is best to focus on the few promising individuals who can reap the most benefits from the intervention and provide good returns on investment for the company's human development and future business operations.

The selection of learners for participation in various programmes can thus be a complex and sensitive undertaking for any donor or service provider, with many ethical, financial and political considerations to take into account. For this reason the selection process is usually delegated to the education authorities, such as school principals and circuit managers (with some general guidelines from the corporate donors), or done by the service providers (eg, Radical Math & Science), which often conduct entry tests and assessments as part of the selection process.

Regardless of the methods employed in the selection process, usually the brightest and best performing learners in each class and school are selected to take part in the programme. This phenomenon is not limited to Anglo: almost all corporate institutions and NGOs running education interventions in the provinces function in this way. This causes two major problems. The first is that programmes can be accused of being discriminatory: the learners who need the most help are left behind, while the learners who would have performed well anyway receive even more support. There is a strong correlation between interventions and the increase in the number of 'bachelor passes', but less correlation between interventions and the 'overall pass rates' of schools.

All the service providers contracted by Anglo American Platinum (Radmaste, Radical Math & Science, Star Schools) diligently conducted pre- and post-tests, continually demonstrating the success and positive growth of the beneficiaries as a result of their participation in the programmes. From a scientific point of view, however, these 'before and after' assessments must be taken with a pinch of salt. They are done without a counterfactual (control group) and therefore claims of causality need to be considered with caution, as those participants would probably have improved their results even in the absence of the programmes. From a methodological point of view, the above process will inevitably fall victim to 'selection bias' and thus should be addressed accordingly during the impact evaluation work.

To complicate things further, these selection parameters for schools and learners have not been applied strictly across the two provinces. During the field visits it became evident

that some of the more active district and circuit managers and school principals advocated for the inclusion of all the learners in their schools even if they were outside the 50 km radius. Some of these schools have also been resourceful and found ways to multiply and cascade the support that a few learners received from the mining companies by making photocopies of the materials and asking the learners who participated in workshops to share their knowledge with those of their peers who were not able to participate, for example, in the winter schools.

Implementation challenges

As the research team conducted field visits and interacted with local stakeholders, it became apparent that there were many issues with and shortfalls in the way that some components of the programmes were implemented.

In many of the towns, villages and locations in Limpopo and North West, the mining companies' contributions to local infrastructure were very visible. These contributions included the construction, renovation and refurbishment of schools. Signboards and plaques had been erected at many schools acknowledging corporate donations and support, and various individual school principals also expressed their gratitude over these contributions. In some instances, however, the infrastructure projects had not been thought through carefully or had been implemented incorrectly, rendering the new structures and facilities unusable. Some schools ended up with new toilets or labs, but without provision for running water having been made.[40]

Generally speaking, most of the schools, especially those in Limpopo, are accessible only via dirt roads and lack appropriate classrooms, basic infrastructure and facilities, which are critical for a good learning environment. All the schools pleaded for support

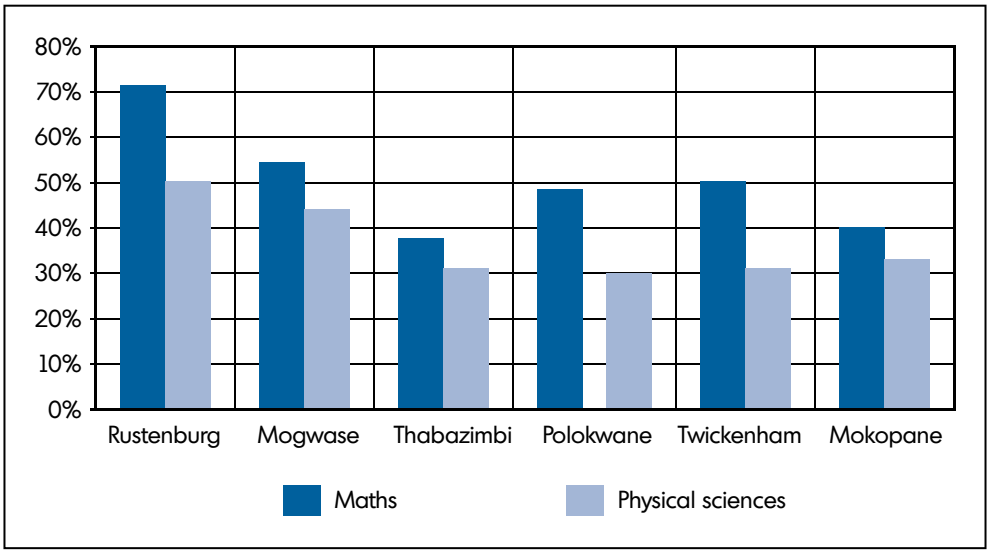
A learner from Mahlogedi Secondary School (Limpopo) in a pristine high-tech physical sciences lab built by Anglo American Platinum that has no running water

from mining companies and other stakeholders for functioning science labs, which would greatly enhance the learning experience and hence the pass rates in this important subject.

Aside from the hard infrastructure, mining companies have also endeavoured to run 'soft programmes', ie, workshops and training programmes for both learners and educators, to improve the learning outcomes of schools in their mining areas. One of the most prominent of these has been Anglo American Platinum's Radical Math & Science learner enrichment programme, particularly the winter camps organised in 2011 and 2012. These were very popular among the stakeholders who benefitting from them. For young people particularly, it is an exciting and motivational experience to leave their hometowns, be taken to a new place and spend a week with other youths in a camp where extra learning, as well as a lot of fun and socialising, take place.

An interesting phenomenon that the research team noticed is that in 2011 the winter enrichment workshops were organised in different locations – Rustenburg (Omaramba Holiday Resort), Mogwase (Manyane Game Lodge), Thabazimbi (Hoërskool Frikkie Meyer), Polokwane (Motse Maria High School), Mokopane (Waterberg High School) and Twickenham (Phatudi Education Centre). The venues chosen differed considerably in terms of accommodation, catering and comfort levels, and ranged from fancy resorts to modest rural facilities. The service provider report illustrates the performance of the different workshop groups in Figure 13.

Figure 13: Average test scores of learners in various locations



Source: Radical Math & Science, Report, Winter School Camp 2012. Johannesburg: Retque 201 cc., 2012

Aside from criticism over the fairness of the process through which resources were distributed and venues were chosen, the graphs show interesting trends regarding the performance of the different workshop groups. Were the different levels of progress measured by each group affected by the comfort and environment provided by the venue, or were the groups who performed better (Rustenburg and Mogwase) already

more advanced due to the existing socio-economic differences between North West and Limpopo learners?

For the facilitators (maths and science instructors) of the various workshops Radical Math & Science used educators from local schools with whom it had worked in the past. This appears to be good practice in principle, as it provides both employment and additional income to local people, and it also ensures that the relevant schools absorb the benefits in the long run. However, the education authorities and circuit managers complained that the facilitators chosen by the service provider were educators who everyone knew were already performing badly in the schools from which they came. 'How can an educator who already has low pass rates in his own school be teaching the students of others?'[41] The selection process for the winter school facilitators was not very clear or transparent and at times lacked credibility.

Anglo's teacher training intervention through Radmaste Centre was generally appreciated and viewed as being more sustainable and useful to improving the overall school system, but it did not last long enough and required more investment in resources to have a meaningful impact. Learners and teachers generally appreciated the study guides and LTSMs that were provided as part of the various learner and educator programmes.

Strategy, co-ordination and alignment with government

As discussed earlier, in the past few years challenges in the platinum industry have affected Anglo American Platinum and therefore also its CED work. The financial crisis in the industry, coupled with the strenuous retrenchment process, disruptions by the strikes, labour disputes and the Marikana incident, have put a strain on the company and its budget, including the funds available for community development. In addition, its CED operations have gone through a high staff turnover in the last few years, and many officials have been shifted around from one mine to another, thereby affecting the continuity and productivity of Anglo American Platinum's CED work and stakeholder relations. This has also had an impact on the overall vision and understanding of the company's CED and education strategy. Due to the nature of mining operations, corporate community development (and thus education) interventions have often been ad hoc and reactive to community demands, trying to keep immediate stakeholders happy rather than devising systematic, structured and long-term developmental strategies.

The company has often tried to do many things merely adequately rather than focussing on a few things and doing them well. Logic models, project designs and monitoring and evaluation frameworks have also been fairly weak. Consultation and alignment with the national and provincial department of Education's planning processes are also problematic. As discussed, Anglo American Platinum usually signs MoUs with MECs or the HoDs of provincial Departments, so the expectation would be that more detailed planning and consultations would occur at the lower level between company officials and local education authorities. However, it became clear from interactions with district and circuit managers in the various mining areas that no one had seen the MoU between the company and the provincial Department of Education, and that most schools and education officials were unclear about the purpose, principles and strategy behind the company's education interventions. In those areas with strong individuals and where personal ties between Anglo American Platinum and provincial Department of Education officials are strong,

such as Rustenburg, Mokopane, Thabazimbi and Mokgodumo, the consultation and joint planning process was much more effective. But in the great majority of mining operational centres, school principals, circuit managers and other local education players complain that mining companies' engagement with the government is very poor. The companies are criticised for not consulting properly with local stakeholders, 'coming to the schools with pre-conceived projects which do not necessarily reflect the real local needs'.[42]

The main interaction that school directors reportedly have with Anglo American Platinum is when the company comes to 'ask for kids' to participate in its camps and other learner programmes. Some stakeholders have also stated that they would like the company to be more transparent with the education budget it has at its disposal and to consult more with local schools on how best to spend those limited resources.

In a few instances there have also been cases of duplication and clashes between Anglo's efforts and those of other organisations running similar activities. For example, the Radical Math & Science winter schools have at times clashed with similar winter camps planned by local schools and circuit/area administrations. In some areas, Anglo American Platinum struggles to lead on a strong teacher-training programme, as it has to compete with other well-established educator development programmes such as those run by the Royal Bafokeng Institute (RBI) in Rustenburg and those run by Kumba/Mpower in Thabazimbi. In Limpopo there is little co-ordination and integration with the province's teacher development centre of Mastec.

Teachers are top!

Although the focus of the study was on the mining companies and other external interventions, one fact that emerged very strongly in discussions with all the stakeholders was that the single most important factor determining better learning results was the teachers. This is extensively discussed in general education literature.[43] The quantity, quality and commitment of educators in a school is the prime factor in driving pass rates up, and therefore the evaluation team took the liberty of investigating this aspect a bit further.

The shortage of maths and science educators in the system has underlined the importance of recruitment and training programmes such as the 'Funza Lushaka' scholarship programme, which is currently scheduled to be evaluated by the government. In both Limpopo and North West, it was clear that there was a large number of Zimbabwean, Indian and other foreign teachers to compensate for the lack of properly qualified South African teachers in the system. The issue of Zimbabwean teachers is highly controversial, as it has an impact on South Africa's immigration policy. On the one hand, some education officials would like to curb the employment of foreign teachers in order to give more jobs to South Africans. On the other hand, it is clear that many school principals prefer hiring foreign educators, who appear to perform better than South African educators, despite having to deal with considerable red tape to do so. The research team is keen to explore this aspect in more depth in a follow-up study.

When assessing the quality of the teachers, many differing opinions emerged. Are the 'new' educators trained at the content-rich universities better than the 'old' educators trained pre-1996 in the teacher-training colleges, which were stronger in terms of pedagogical methods and practical experience? Although not much drastic change

can occur in the current cadre of educators of the country, it may be more apposite for corporate investors, the government and other institutions to look at upgrading continuous in-service teacher development. Currently there are many different educator development programmes, models and approaches in South Africa. In Limpopo and North West the research team identified numerous educator development programmes run by different institutions, such as those of Radmaste (Anglo American Platinum), RBI, Mastec (Limpopo Department of Education), Dinaledi (national Department of Education) and Mpower (Kumba), to name a few. Considering the centrality of educators to the schooling system, it is important to do more in-depth evaluation of these teacher development programmes and to identify which ones seem to have greater impact on learning results in the long term.

Leadership, management and accountability

Strongly linked to the quality and performance of educators is the issue of the school principal's leadership and commitment, as highlighted in the diagnostic report by the National Planning Commission in 2011. It was clear to the research team that among the schools that were visited, the best performing ones were usually those with a strong, dedicated and competent school director. This could even be assessed from the appearance of the school (the cleanliness, order and neatness of the facilities). Strong school organisation and management, a solid teacher accountability system, regular learner assessments, feedback to and engagement with parents, and the organisation of extra-curricular activities, fundraisers, additional workshops and other special initiatives to improve learning outcomes, were all factors present at the most successful schools visited. In this regard, awards for the best principals, teachers and learners can act as a good incentive mechanism to improve educational outcomes in the public school system. The importance of school management, good governance and leadership in achieving high learning results is also consistent with much of South African education literature.[44]

Unintended impact of the mines

As the research team immersed itself in the field and interacted with various stakeholders, a very interesting hypothesis emerged, especially from conversations with school principals. Rather than acting as a stimulus to better pass rates, the presence of a mine close to a school actually has a negative effect on education outcomes. There are some obvious negative consequences to having a mine in a community, such as the frequent protests and unrest that disrupt local community affairs, including schooling activities. But a more interesting phenomenon is that when a mine is present in a rural community, the people develop high expectations for employment and the improvement of their livelihoods through linkage with that mine. Families also know that the jobs required by the mine are more technical and engineering related. As a result, there is a strong push for learners in mining areas to take subjects such as maths, physical and natural sciences, geography and technology, which would allow them to later enter university courses and apprenticeship programmes that would increase their chances of employment in the lucrative mining industry. This tendency, however, also sees learners who do not have an aptitude for maths and science enrolling in scientific and technical subjects in

the NSC examination, leading to a glut of learners in subject areas that are not properly resourced with good educators, facilities and materials. Since more ill-prepared learners take these subjects, more learners around the mines actually end up failing the grade 12 examination compared to other areas. This is consistent with the general trend observed earlier at provincial level, where an increase in pass rates is strongly linked to a decrease in NSC exam enrolments in maths and science, and vice versa. The researchers felt obliged to further test and check this hypothesis through the quantitative analysis laid down in the next few sections.

RESULTS OF THE ECONOMETRIC ANALYSIS

Before undertaking the more rigorous experimental and quasi-experimental impact evaluation, the research team ran a few multiple regressions on the (y) outcomes variables of MATHS_PASS, MATHS_EXCEL, PHYSICS_PASS and PHYSICS_EXCEL from the 2012 NSC exam results in Limpopo and North West. Almost all the interventions, as well as the school administrative and demographic factors (a total of over 130 explanatory variables for over 1 400 schools), were used and tested in the regression model. The objective was to have a rough indication of which factors significantly and strongly correlate with learning results, and to explore these aspects further during the subsequent experimental work. The important variables would also be used as covariates for the propensity score matching and as controls during the impact assessment work.

Through SPSS, a step-wise regression model was used using a 95% confidence level on all four outcome variables. Usually by the seventh or eighth step, most of the variables would be dropped and the only ones that would remain were the ones that were statistically significant in the model. The regression tables (Tables 3, 4, 5 and 6) also indicate the coefficients of the variables that are statistically significant, thus giving a good indication of those factors that have the most impact on learning outcomes.

Table 3: Regression on maths passes (above 30% score)

Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Std. error	Beta		
8	(Constant)	.401	.030		13.561	.000
	English_Excel_2012	.377	.028	.330	13.412	.000
	AverageFees	2.196E-005	.000	.164	6.207	.000
	Distance_mine	.000	.000	.088	3.266	.001
	LearnerEducator_ratio	-2.504	.492	-.121	-5.086	.000
	Math_Enrol_2012	-.128	.028	-.108	-4.503	.000
	EngAfr_HLang_learners	.001	.000	.094	3.716	.000
	OwnerLand	.160	.050	.076	3.174	.002
	VHEMBE	.052	.019	.075	2.794	.005

Source: Produced by the author through SPSS, 2013

Table 4: Regression on maths excel (above 50% score)

Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Std. error	Beta		
7	(Constant)	.276	.040		6.931	.000
	English_Excel_2012	.167	.018	.228	9.177	.000
	AverageFees	1.676E-005	.000	.196	7.578	.000
	Per_black_learners	-.002	.000	-.165	-6.168	.000
	LearnerEducator_ratio	-1.467	.310	-.111	-4.728	.000
	Quintile	.013	.004	.073	2.857	.004
	VHEMBE	.032	.010	.071	3.050	.002
	TotalMSTEduc	.005	.002	.068	2.916	.004

Source: Produced by the author through SPSS, 2013

Table 5: Regression on physics passes (above 30% score)

Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Std. error	Beta		
7	(Constant)	.479	.028		17.276	.000
	English_Excel_2012	.346	.029	.288	12.029	.000
	VHEMBE	.153	.017	.211	9.102	.000
	AverageFees	1.787E-005	.000	.127	4.813	.000
	LearnerEducator_ratio	-3.407	.517	-.157	-6.589	.000
	WATERBERG	-.143	.039	-.084	-3.623	.000
	OwnerLand	.199	.053	.090	3.754	.000
	EngAfr_HLang_learners	.001	.000	.084	3.294	.001

Source: Produced by the author through SPSS, 2013

Table 6: Regression on physics excel (above 50% score)

Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Std. error	Beta		
8	(Constant)	.281	.049		5.800	.000
	English_Excel_2012	.188	.019	.240	10.065	.000
	AverageFees	1.942E-005	.000	.212	8.127	.000
	LearnerEducator_ratio	-2.236	.323	-.158	-6.924	.000
	Per_black_learners	-.002	.000	-.118	-3.486	.001
	VHEMBE	.064	.010	.136	6.158	.000
	Dinaledi	.082	.017	.108	4.775	.000
	EngAfr_HLang_learners	.001	.000	.098	3.049	.002
	OwnerLand	.094	.033	.065	2.844	.005

Source: Produced by the author through SPSS, 2013

Interpretations, explanations and theories

The econometric analysis above confirmed the theories and results that global and South African education literature has previously shown, but it also revealed some interesting new findings. The most influential factor by and large influencing both maths and science pass rates is the pass rates registered by the same schools in English language. This confirms the various theories around the importance of strengthening language skills for all other learning to take place.[45] This is further confirmed by another regression variable strongly correlated to pass rates, namely the percentage of learners whose home language is either English or Afrikaans.

As previously explored by other South African academics,[46] these four regressions demonstrate that socio-economic factors are among the most influential variables for learning results. At the top of the list is the average school fee, which shows that the more families pay (and thus resource and incentivise schools and hold them to account) the higher the pass rates are in those schools. The percentage of black learners is negatively correlated to maths and science results, underlining the still vast racial-social divide that affects the politics and economy of the country. Furthermore, the higher the school quintile, the better the pass rates.

Also widely discussed in the literature[47] is the critical role of teachers in the learning process. This factor is highlighted in the regression models, which show that there is a negative correlation between an increase in educator-learner ratios and a decrease in learning results. A large number of maths, science and technology teachers in the school (Total MST_Edu) also seem to have a small effect on quality maths pass rates.

Interestingly, none of the many external interventions in Limpopo and North West, including the substantial investments by Anglo American Platinum, had a significant impact on learning results. The only intervention that seems to have had some effect on science passes is the government's Dinaledi programme. This confirms the findings of the World Bank evaluation[48] and warrants a re-visiting of the long-term impact of this initiative, considering the programmatic evolution and new delivery approaches that the programme has undertaken since 2008.

Private land ownership also seems to have a small effect on pass rates. Section 14 of the South African Schools Act of 1996 makes provision for public schools that are situated on private property. These can be farms, nature reserves or land belonging to tribal authorities (eg, the Royal Bafokeng). However, most section 14 schools tend to be former Catholic schools and schools managed by other churches and religious groups. These seem to have better learning outcomes than elsewhere in the public school system, possibly because of the staff and learners' commitment and values. Further research in this area could be interesting to explore.

Of the 23 district municipalities that were included as dummy variables in the regressions, the only one that seems to have a strong correlation to pass rates is the district of Vhembe, which is the northernmost district in South Africa, situated close to the border with Zimbabwe. This poor, rural area of Limpopo, formerly part of the Bantustan state of Venda, has a positive correlation with pass rates, which is worth investigating further. Is this related to the education policies of the former Venda homeland[49] or is it because of the district's proximity to Zimbabwe, with the resultant increased access to better trained maths and science educators? Vhembe district is also far from mining operations, which

would exclude a positive impact stemming from the education programmes of Anglo and other mining houses.

These regression models show that pass rates increase the further away the school is from the platinum mine. This further strengthens the theory on mines' negative impact on school results. As shown by the descriptive statistics and the provincial trends presented at the beginning of this report, as well as the regression analysis, an increase in maths enrolments (possibly due to the presence of mines in the area) correlates strongly with a decrease in the pass rates. This will be further explored in the next section.

RESULTS OF QUASI-EXPERIMENTAL EVALUATION

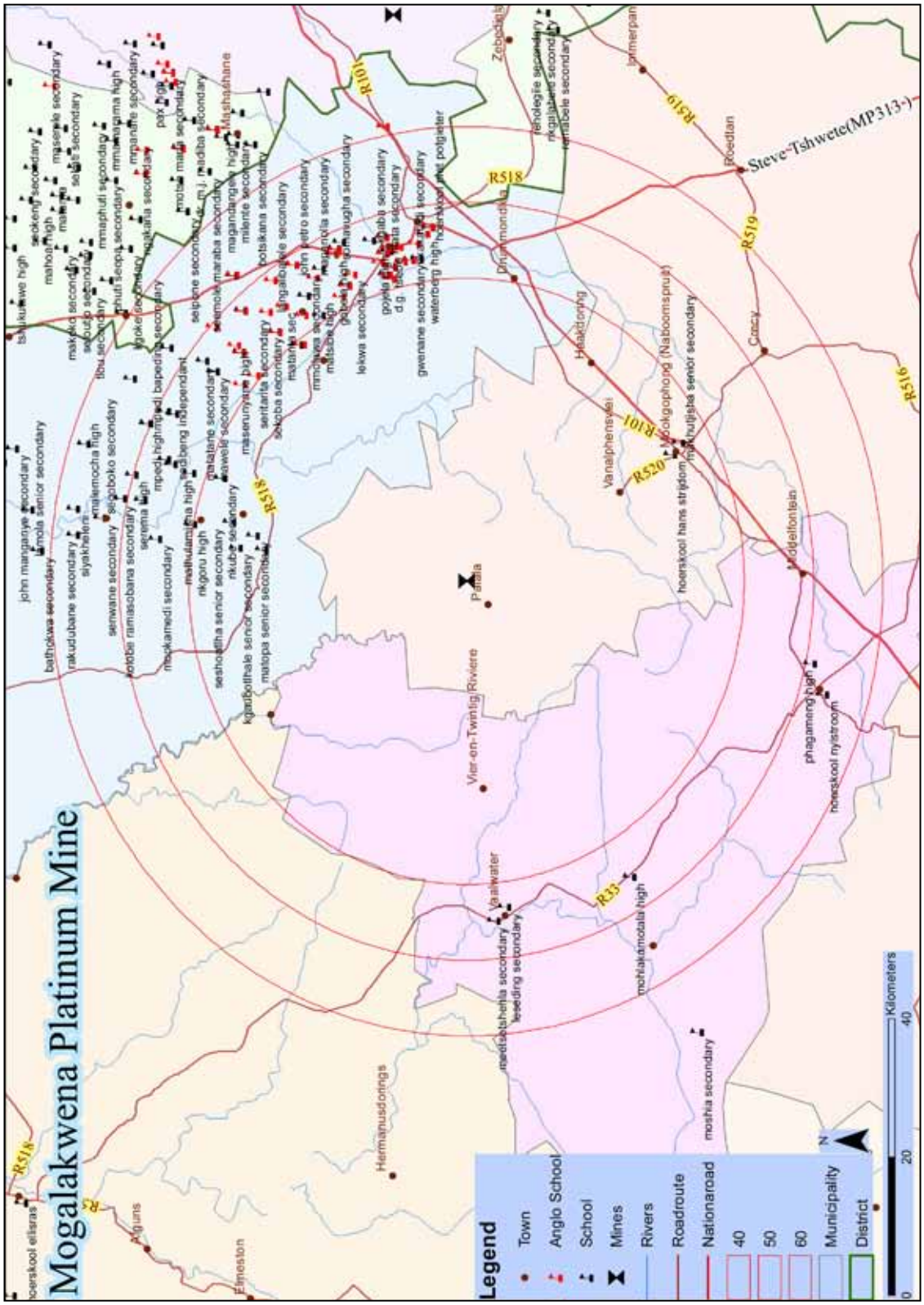
Problems with cut-off-point design

As discussed earlier, in the absence of a randomised control trial, one of the more reliable quasi-experimental methods is that of regression discontinuity design (RDD).[50] However, this method only works if there is a very strict scale-based cut-off point that determines a quasi-random participation and non-participation in the programme. As South African mining legislation and Anglo American Platinum policy was to provide socio-economic support to communities within a 50 km radius of the mine, the research team considered using the 50 km cut-off point as a geographic scale to use as part of this RDD. As a first step, the research team calculated the GIS co-ordinates of the various platinum mines and the schools both serviced and not serviced by Anglo American Platinum. With the assistance of StatsSA, these mines and schools were plotted on maps of Limpopo and North West to observe whether this 50 km selection criterion was applied in a strict and consistent manner. The schools in red (see Figure 14) represent the 'Anglo schools', versus the 'non-Anglo schools' in black, all placed in three buffer zones of 40 km, 50 km and 60 km from the mines. These imaginary lines serve the purpose of allowing for the 40 km to 50 km schools to be treated as the programme group and the schools in the 50 km to 60 km buffer to be used as the control group in a cut-off design evaluation. Figures 14 and 15 show the results for two of the mines (Mogalakwena and Modikwa), illustrating the challenges.

It is apparent from even a glance at these maps that the '50 km rule' has not been applied strictly, systematically or universally. Some schools that are closer than 40 km to the mine have not been included in the Anglo American Platinum programmes, while others that are further away than 60 km have been included. The support received by schools is fairly random and unsystematic, and probably reflects the relationships and levels of advocacy between Anglo American Platinum personnel, education authorities and community leaders.

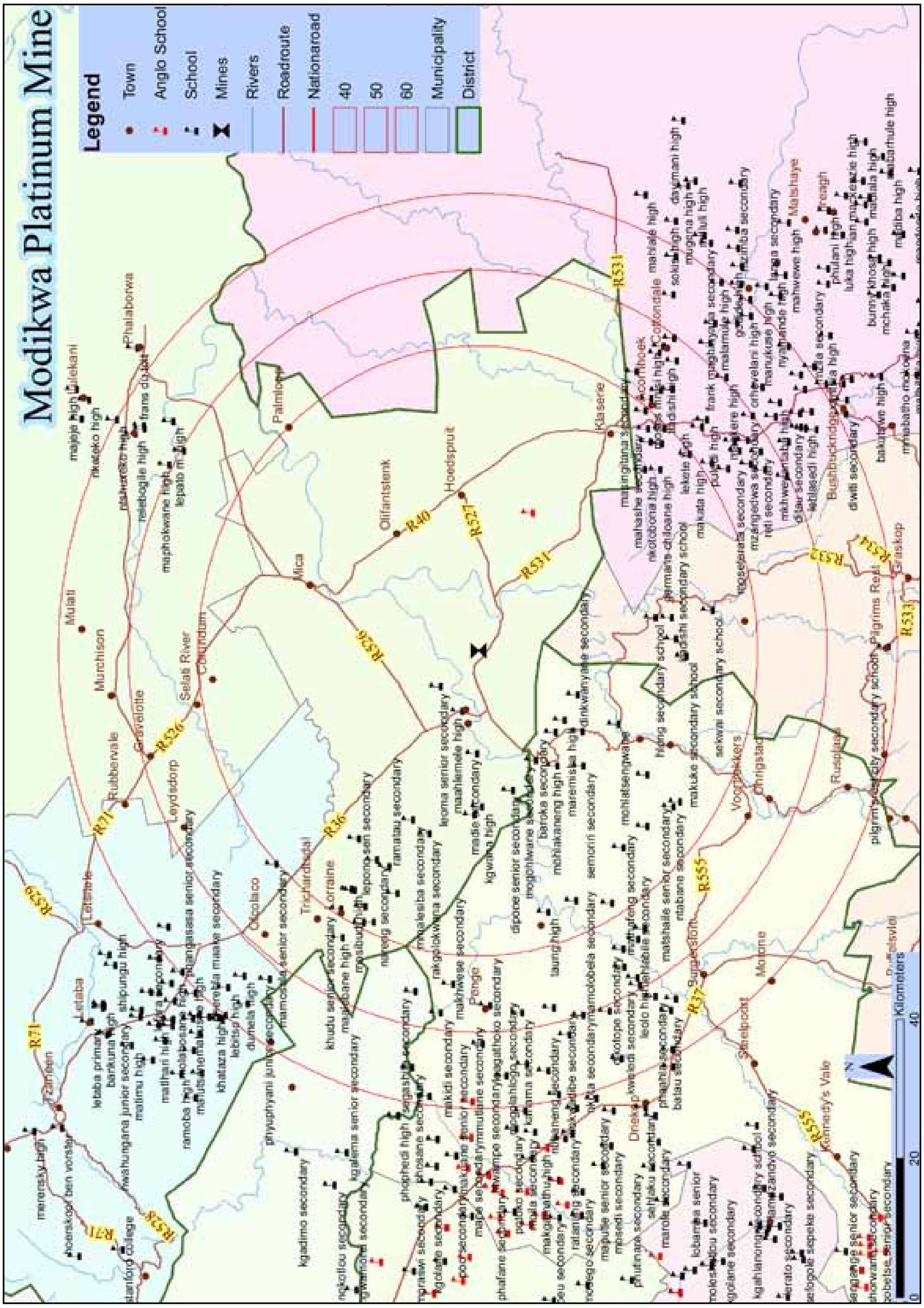
Although this allocation might have made sense and benefitted more schools in programmatic terms, from a research point of view the finding was disappointing: the cut-off-point design impact evaluation method could not be applied. The next best option was to use the propensity score matching method to construct ex-post treatment and control samples to compare during the DID process.

Figure 14: Geo-location of Mogalakwena platinum mine vis-à-vis treated and untreated schools



Source: StatsSA, 2013

Figure 15: Geo-location of Modikwa platinum mine vis-à-vis treated and untreated schools



Source: StatsSA, 2013

The 'proximity to mine' effect

Thanks to SPSS and R plug-ins, propensity score matching was run using 'NatEMIS' as identifier variable and the dummy of '50 km from mine' as treatment variable. Based on theory and previous econometric analysis, the researchers decided to use the covariates listed in Table 7 for the matching process, as these were seen to have a greater determining effect on school results.

Table 7: Covariates used for the PSM

EngAfr_HLang_learners	Quintile	Overall_Passes_2008
Per_black_learners	AverageFees	Bachelor_Passes_2008
Learner-Educator_ratio	SchoolType	Maths_Enrol_2008
Science_Lab	Specialisation	Maths_Passes_2008
Computer_Lab	Land_ownership	Physics_Enrol_2008
Media_Library	Learner-MST_Educator_ratio	Physics_Passes_2008
Multi-group_class	Dinaledi	English_Passes_2008
Total_FET_Learners	Any_Intervention_YES	English_Excel_2008
*Curriculum-variables[51]	*District-location-variables[52]	*Distance_Mine[53]

Source: Author's own compilation, 2014

Matching control schools to treatment schools with regard to the general impact of the mine on learning outcomes was done using the nearest neighbour method through a logit regression, 0,2 calliper matching with a 1:2 ration without replacement. Table 8 illustrates the result of the PSM on '50 km from mine operations'.

Table 8: Sample sizes from the PSM on the proximity to mines

	Control	Treated
All	873	655
Matched	**382**	**293**
Unmatched	491	362
Discarded	0	0

Source: Author's own compilation, 2013, results produced in SPSS

Following the matching and the propensity score balancing, a treatment group of 293 schools and 382 control schools was created. To further reduce the difference between the groups based on unobserved variables, the DID method was introduced in the model.

A simple DID computation was made in SPSS, comparing the NSC results of each school in 2012 (post-test) with those of 2008 (pre-test). For example:

$$DID\ MathPass = (MathPass_{t2012} - MathPass_{t2000}) - (MathPass_{c2012} - MathPass_{c2000})$$

Whereas, for instance,

$MathPass_{t2012}$ is the (%) of learners in the treatment school passing maths in NSC in 2012

$MathPass_{c2000}$ is the (%) of learners in the control school passing maths in NSC in 2008

A DID value was computed for every school in both the treatment and control samples for all eight NSC outcomes of interest, in order to observe not only mean but also standard deviations of the results. An independent sample t-test was thus run to check if the mean difference between the programme and control sample was statistically significant. Table 9 shows the result.

Table 9: Independent samples of t-test on results from schools close to mines versus schools far from mines

		t-test for equality of means				
		t	df	Sig. (2-tailed)	Mean difference	Std. error difference
DID_ OveralPass	Equal variances assumed	-2.162	673	.031	-.04445	.02056
	Equal variances not assumed	-2.183	648.384	.029	-.04445	.02036
DID_ Bachelor	Equal variances assumed	-2.038	673	.042	-.02100	.01030
	Equal variances not assumed	-2.077	663.122	.038	-.02100	.01011
DID_ MathEnrol	Equal variances assumed	1.969	673	.049	.03928	.01995
	Equal variances not assumed	1.990	649.778	.047	.03928	.01974
DID_ MathPass	Equal variances assumed	-1.859	673	.063	-.04684	.02519
	Equal variances not assumed	-1.884	654.988	.060	-.04684	.02486
DID_ MathExcel	Equal variances assumed	-1.674	673	.095	-.02666	.01593
	Equal variances not assumed	-1.714	668.429	.087	-.02666	.01555
DID_ PhysicsEnrol	Equal variances assumed	.557	673	.578	.00902	.01620
	Equal variances not assumed	.555	621.662	.579	.00902	.01625
DID_ PhysicsPass	Equal variances assumed	-1.984	673	.048	-.05141	.02592
	Equal variances not assumed	-1.988	633.817	.047	-.05141	.02586
DID_ PhysicsExcel	Equal variances assumed	-1.473	673	.141	-.02009	.01364
	Equal variances not assumed	-1.496	658.109	.135	-.02009	.01343

Source: Produced by the author through SPSS, 2013

The results in Table 9 demonstrate that, based on a 90% confidence interval, most differences are statistically significant, therefore the proximity to the mine (within 50 km) did indeed have a small impact on the results.

To arrive with more precision on the magnitude and direction of the impact, an effect size calculator was used by plugging in the mean, standard deviation and sample sizes of both treatment and control, gathered through the t-test. The results are presented in Table 10.

Table 10: Effect size of 'proximity to mines'

	Treatment			Control			Effect size
	Mean	SD	N	Mean	SD	N	
Maths enrol	-0,0948	0,24548	293	-0,1341	0,26524	382	0,153232787
Maths pass	0,0449	0,30572	293	0,0917	0,33804	382	-0,144474864
Maths excel	-0,0040	0,18344	293	0,0226	0,22026	382	-0,129886647
Physics enrol	-0,0133	0,21110	293	-0,0224	0,20667	382	0,043688172
Physics pass	-0,0141	0,33035	293	0,0373	0,33632	382	-0,154239456
Physics excel	0,0660	0,16393	293	0,0861	0,18405	382	-0,114632219
Overall pass	0,0648	0,25388	293	0,1093	0,27274	382	-0,168350385
Overall batch	0,0452	0,12167	293	0,0662	0,14050	382	-0,158535961

Source: Author's Own Compilation, 2013

Both the t-test and the effect size calculation show that proximity of 50 km to a mine does indeed have a negative effect on overall learner passes, as well as maths and physics achievement. From Table 10 it also appears that the presence of the mine seems to have a small positive correlation with enrolments in maths and science exam subjects, but a negative correlation with pass rates. To translate these results in the education setting of Limpopo and North West, Table 11 shows how much schools close to the mines suffer percentage scores reduction in overall pass rates compared to other schools in the two provinces.

This further confirms the previous regression analysis as well as the theory of the negative impact of mines on local schools that emerged during the qualitative fieldwork.

Table 11: Handicap on pass rates caused by schools' proximity to mining operations

All schools in North West and Limpopo			Schools within 50 km of mines	
NSC results 2012	**Average**	**Standard Deviation**	**Effect size**	**Increase/decrease in pass**
Overall pass	60,5%	21%	-0,168350385	-3,5%
Bachelor pass	14,5%	15%	-0,158535961	-2,5%
Maths participation	52,5%	25%	0,153232787	4,0%
Physics participation	39,0%	22%	0,043688172	1,0%
Maths pass	45,0%	26%	-0,144474864	-4,0%
Physics pass	57,5%	26%	-0,154239456	-4,0%
Maths excel	18,0%	17%	-0,129886647	-2,0%
Physics excel	12,0%	18%	-0,114632219	-2,0%

Source: Author's own compilation, 2013

Impact of Anglo American Platinum's education programme

The big question that remained was whether Anglo American Platinum's massive education programme implemented in the communities around its mining operations managed to reverse some of these trends and have a positive impact on the learning outcomes of the schools it supported. Did the Anglo American Platinum CED investments in the Limpopo and North West education sectors from 2009 to 2012 turn out to be effective? Once again, considering the circumstances, the best way to undertake this impact assessment was by combining propensity score matching (PSM), DID, students' t-test and Cohen's d effect size calculation, as undertaken above when measuring the impact of the proximity of the mine.

In the section on education interventions by Anglo American Platinum it was shown that its education programme consisted of a number of different interventions (infrastructure projects, Radmaste teacher training, Star Schools, Radical Math & Science Saturday and winter schools, etc.) implemented in different dosages in over 100 schools across Limpopo and North West. In order to maximise the potential effect of Anglo American Platinum's education programme, the researchers decided to combine the various interventions into one mega Anglo programme dummy variable (indicated as Anglo_Yes), and use the entire population of 134 Anglo schools that received any type of treatment from the company to draw up the programme sample.

The treatment samples and control samples were created using the same covariates used above in the PSM for the '50 km from mine effect'. The main difference this time in the PSM was that the 'distance_mine' variable was added to the pool of covariates and the treatment became the dummy variable of 'Anglo_Yes'. The same PSM process as before was run by using the nearest neighbour method, logit regression, 0,2 caliper, but this time with a 1:3 ratio without replacement, and without discarding cases from the programme group as it was more difficult to find enough good matches for the Anglo schools. The result was the samples listed in Table 12.

Table 12: Sample sizes from PSM on overall Anglo programme

	Control	Treated
All	1 393	134
Matched	**159**	**90**
Unmatched	822	44
Discarded	412	0

Source: Author's own compilation, 2013

The same process outlined above (calculating the DID for all eight different NSC result outcomes, conducting an independent samples t-test for significance in the mean difference between programme and control group) was now done to assess the impact of the overall Anglo American Platinum education interventions package. Table 13 shows the results.

Table 13: Independent samples t-test on schools receiving support from Anglo versus schools that do not

		t-test for equality of means				
		t	df	Sig. (2-tailed)	Mean difference	Std. error difference
DID_Math_Enrol	Equal variances assumed	.252	247	.801	.00840	.03335
	Equal variances not assumed	.244	166.953	.808	.00840	.03450
DID_Math_Pass	Equal variances assumed	-.067	247	.946	-.00262	.03896
	Equal variances not assumed	-.068	191.275	.946	-.00262	.03852
DID_Math_Excel	Equal variances assumed	-.493	247	.622	-.01233	.02500
	Equal variances not assumed	-.501	193.520	.617	-.01233	.02462
DID_Physics_Enrol	Equal variances assumed	-.891	247	.374	-.02187	.02453
	Equal variances not assumed	-.890	184.301	.374	-.02187	.02456
DID_Physics_Pass	Equal variances assumed	.092	247	.927	.00394	.04275
	Equal variances not assumed	.090	169.363	.929	.00394	.04401
DID_Physics_Excel	Equal variances assumed	-1.312	247	.191	-.02746	.02093
	Equal variances not assumed	-1.374	211.049	.171	-.02746	.01998
DID_Overal_Pass	Equal variances assumed	.453	247	.651	.01503	.03316
	Equal variances not assumed	.432	159.961	.666	.01503	.03479
DID_Overal_Batch	Equal variances assumed	.246	247	.806	.00383	.01560
	Equal variances not assumed	.251	197.708	.802	.00383	.01525

Source: Produced by the author through SPSS, 2013

From the t-test it appears that none of the differences between the mean of the control group and the programme group is statistically significant. To confirm this, Cohen's d for the eight NSC outcomes was calculated (see Table 14).

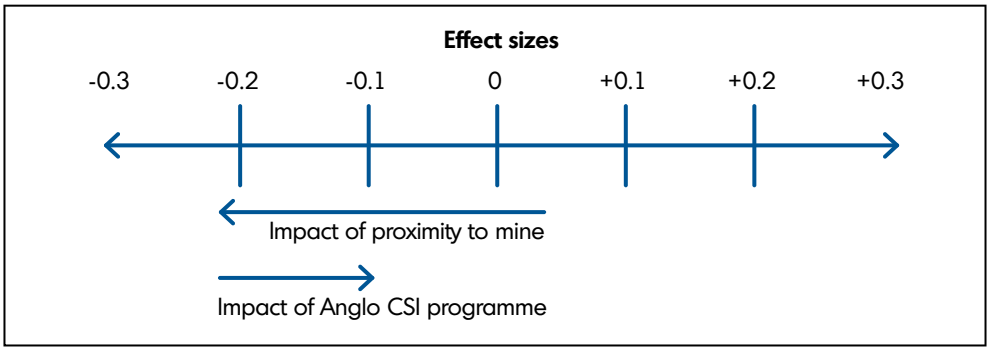
Table 14: Effect size of overall Anglo American Platinum education programme

	Treatment			Control			Effect size
	Mean	SD	N	Mean	SD	N	
Maths enrol	-0,0893	0,27241	90	-0,0977	0,24113	159	0,033355863
Maths pass	0,0856	0,2876	90	0,0883	0,29961	159	-0,009178981
Maths excel	0,0101	0,18281	90	0,0225	0,19318	159	-0,065696675
Physics enrol	-0,0099	0,18645	90	0,0120	0,18573	159	-0,118224175
Physics pass	0,0508	0,34564	90	0,0469	0,31127	159	0,012082886
Physics excel	0,0698	0,14168	90	0,0973	0,16745	159	-0,174040523
Overall pass	0,1229	0,27894	90	0,1079	0,23438	159	0,059919317
Overall batch	0,0631	0,11209	90	0,0593	0,12163	159	0,032256631

Source: Author's own compilation, 2013

The SMD effect size calculator also shows that the impact of Anglo American Platinum's education interventions on learning outcomes in treatment schools is not statistically significant[54] and produces only a very tiny effect. In the few cases where the results are slightly more significant, the impact coefficient remains negative. The results overall are not encouraging. However, this does not necessarily mean that the Anglo American education intervention was per se ineffective. Rather, in light of the previous results on the impact of the schools' proximity to the mines, it highlights that the small effect of these programmes was not strong enough to counter-balance the large negative effect caused by the school's presence near a mining operation. This concept is illustrated in Figure 16.

Figure 16: Illustration of the competing effects of Anglo programme and proximity to mine on learning outcomes of schools



Source: Author's own compilation

THE EVALUATION PARADOX

As the results of the overall Anglo American Platinum FET interventions did not appear very positive, the analysts decided to scrutinise the education programme to try to measure separately the individual components of the bigger education programme run by Anglo. One of the easiest and more sensible interventions to look at was the Radical Math & Science winter camp for grade 12 learners, implemented in 2012 for 958 learners across the Anglo operation areas, which cost the company over ZAR 3.3 million (about $470,000). According to the service provider's report, learning assessments were conducted on all the learners participating in the workshop before and after the training to observe how effective the programme had been in improving the test scores of participants in maths and physical sciences, among several other subjects.[55]

Table 15 shows that the 2012 winter camp assisted learners to improve their maths and physics test scores by an average of between 12 and 33 percentage points. One can thus conclude that the programme was very successful. There are obviously some problems in using this assessment approach when conducting scientific impact evaluations (these problems will be discussed in the next few pages). However, one can at least assume that the programme must have had some level of impact on the participants who were selected to join the 10-day workshop.

Table 15: Average results from pre- and post-tests of learners attending 2012 winter enrichment programme

Area	Number of learners	Average days attended	Average maths test results (%)			Average physics test results (%)		
			Pre	Post	Improv.	Pre	Post	Improv.
Rustenburg	170	10	46	69	22	16	48	33
Thabazimbi	198	10	38	52	13	11	41	31
Polokwane	164	10	35	56	21	8	39	31
Mokopane	210	10	35	56	21	8	39	31
Twickenham	216	10	45	58	12	15	41	25

Source: Radical Math & Science Winter Camp 2012 report[56]

But did the treatment of such a select group of participants have an impact on the overall results of the schools whose learners participated in the programme? If what is being measured is the NSC passes from the school perspective, it is very important to assess whether enough learners from the Anglo-supported schools participated in the winter camp to have a significant impact on the entire school system. The research team estimated the percentage of learners in treated schools by dividing the number of participants from each school in the Anglo 2012 winter school by the number of learners who enrolled in the same year (2012) in the NSC exam, as well as their enrolment in the specific subjects of maths and physical sciences[57] (see Appendix 6).

On average, 37% of the grade 12 learners and about 72% of the learners who wrote the maths or physics NSC exams participated in the Radical Math & Science winter camp in 2012, thus providing a big enough sample of participants to potentially have a significant effect on the overall school results at NSC exams in 2012, at least for the specific subject areas. In addition, 2012 should also be in theory the year in which the 2010 grade 10 learners involved in the Radical Math & Science A-Team Saturday extra classes reached grade 12, thus adding additional effect to Anglo-treated schools.

As in previous calculations, propensity score matching, DID and t-test were run in SPSS using as treatment variable the dummy 'Wintercamp_2012', with the results shown in Tables 16 and 17.

Table 16: Sample sizes from PSM on 2012 winter school

	Control	Treated
All	1 491	37
Matched	44	35
Unmatched	164	2
Discarded	1 283	0

Source: Author's own compilation, 2013

Once again, when looking at the impact of the programme on all of the schools participating, the learner enrichment winter camp and the additional spillover from the A-Team Saturday classes did not produce a significant impact on overall and subject-specific pass rates in 2012, as would be expected. Another t-test was subsequently run on the control and treated matched samples, this time removing four cases that represented schools with a low level of learners participating in the Anglo American Platinum programme (below 25%), and still no statistical significance emerged.

Table 17: Independent samples t-test on NSC results of schools attending 2012 winter schools versus those who did not

		t-test for equality of means				
		t	df	Sig. (2-tailed)	Mean difference	Std. error difference
DID_Math_Enrol	Equal variances assumed	.938	77	.351	.05957	.06349
	Equal variances not assumed	.914	63.902	.364	.05957	.06518
DID_Math_Pass	Equal variances assumed	.350	77	.727	.00968	.02766
	Equal variances not assumed	.341	64.208	.734	.00968	.02837
DID_Math_Excel	Equal variances assumed	.818	77	.416	.05388	.06583
	Equal variances not assumed	.803	66.856	.425	.05388	.06706
DID_Physics_Enrol	Equal variances assumed	.205	77	.838	.00841	.04094
	Equal variances not assumed	.205	72.260	.838	.00841	.04105
DID_Physics_Pass	Equal variances assumed	.808	77	.422	.05615	.06951
	Equal variances not assumed	.814	75.061	.418	.05615	.06894
DID_Physics_Excel	Equal variances assumed	-1.232	77	.222	-.03381	.02744
	Equal variances not assumed	-1.237	74.071	.220	-.03381	.02733
DID_Overal_Pass	Equal variances assumed	-1.984	673	.048	-.05141	.02592
	Equal variances not assumed	-1.988	633.817	.047	-.05141	.02586
DID_Overal_Batch	Equal variances assumed	-1.473	673	.141	-.02009	.01364
	Equal variances not assumed	-1.496	658.109	.135	-.02009	.01343

Source: Produced by the author through SPSS, 2013

All the other learner interventions implemented between 2009 and 2012 by the company benefitted an even smaller number of participants from the various Anglo-treated schools (on average between 4% and 55%), and therefore they were even less likely to produce a significant impact on the whole school's results. In theory, some of the more systemic interventions should have a bigger impact on school-level outcomes. However, the infrastructure projects implemented in the period 2009–2012 were only a handful (seven science labs and three computer labs), often not functional and not impactful enough to cause a direct correlation with learning outcomes (see previous section on the results of the econometric analysis).

The Radmaste teacher training programme, also implemented in 2012, could have been a promising intervention as it affected educators, who have a more systemic and long-term effect on school performance. The dosage was also reasonable as it affected 17 to 100% (61% on average) of the maths, science and technology (MST) teachers from 29 Anglo programme schools.[58] However, as discussed in earlier sections, for financial and logistical reasons the programme could not be implemented according to the original plan and ended up being conducted with a smaller group and over a shorter timeframe

in order to produce quick results for the 2012 NSC examinations. Considering that the Radmaste teacher development intervention occurred between July and September, that the academic year was near end and most of the teaching had already occurred, it had little time to cascade into improved teaching, learning and results in the NSC exams of 2012. It would thus be more reasonable to assess the impact of this teacher-training programme once the 2013 NSC results are made available by Umalusi.

Problems with CSI programme designs and evaluations

These findings also provide insights into some of the challenges and conundrums in development evaluation. Economists such as Mosley,[59] Boone[60] and Picciotto[61] have discussed in their evaluation studies the 'micro-macro paradox'.[62] In the evaluation of the Anglo CED programmes instances of this 'paradox' were also detected, where positive results from the assessment of individual participants at the micro level do not necessarily translate into positive results at the macro-system and broader-sector level. This is due to several challenges and limitations, particularly the lack of objectivity and scientific rigour often prevalent in evaluations of NGOs, corporates and donors.[63] In this particular case, service providers such as Radmaste and Radical Math & Science conducted the project-level impact assessments with learners and educators shortly after a workshop had been conducted. However, this does not necessarily mean that the knowledge gained will be retained and translated into behavioural and institutional changes several months or years down the line, where many other forces are at play that might affect the final outcome (in this case, improved learning results). This is also consistent with the findings[64] that explain that lower effect sizes are expected in the education sector when assessing whole school interventions compared with the evaluation of small groups or one-on-one tutoring. NGOs, corporate investors and development agencies often provide support to a small sample of individuals, who are not enough to make a significant change in the broader system.

A more serious weakness of project evaluations (such as the ones by the Anglo service providers) is that they are done lacking a counterfactual (or control) group. The improvement in the learning results of the participants is a normal trend and could have occurred regardless of the programme. Therefore, claims to causality and attribution made by a programme need to be taken with caution in the absence of an experimental setting. Also very common in development evaluation is the occurrence of the 'Hawthorne Effect',[65] where participants perform better simply because they are under observation, but these results do not endure in the long run once the evaluation and intervention are finished. Finally, one cannot exclude the possibility of a 'funding bias' when service providers conduct evaluations of their own programmes for the donors who fund them, avoiding reporting on the negative aspects of their programmes and highlighting the positive results.

CHAPTER 4

CONCLUSIONS

BOTTOM LINE FOR ANGLO AMERICAN PLATINUM

Based on the records and documentation provided by the company, between 2009 and 2012 Anglo American Platinum implemented an education programme costing almost ZAR 100 million ($14 million) in support of the schools and communities around its mining operations in Limpopo and North West. The FET programme was implemented through a number of service providers (Radical Math & Science, Radmaste Centre, Star Schools, etc.) and consisted of learner enrichment programmes (through Saturday classes and winter camps), teacher training and some infrastructure and facility upgrades. One of the prime development objectives of the programme was to increase pass rates and learning results, particularly in the critical subjects of maths and the sciences.

There were clearly some design problems as well as a number of implementation challenges in Anglo American Platinum's programming, which raised concerns among various education sector stakeholders. Although the few selected beneficiaries (learners and teachers) appreciated and benefited from the Anglo programmes, the interventions were too small to translate into significant gains for the general school systems of Limpopo and North West. Rigorous and scientific impact assessments of the Anglo American Platinum education investments did not reveal a statistically significant effect of the programme on the maths and science results of beneficiary schools. The small positive effect of Anglo's interventions was outweighed by the large negative unintended effects that the mere presence of its mines had on the learning outcomes in schools surrounding the platinum operations. The study demonstrates that there is a strong negative correlation between the proximity of a school to a mine and a decline in its maths and science pass rates. This phenomenon goes beyond the well-intended education interventions of the company and is rooted in the larger socio-economic challenges faced by the communities living around mining areas.

Consequently, the investments made by Anglo American Platinum between 2009 and 2012 provided relatively small returns on education and development outcomes at the system level. Generally, the company tried to do too many things in too small doses, thus reducing its chances of making a deep and lasting impact. The most promising initiative was probably the educator training, but this was also done with too small a group and too little time to allow for a visible effect.

However bleak, the findings of this evaluation should not discourage mining companies from investing in education. On the contrary, further and more concerted attention needs to be paid to holistic interventions, ranging from professional and tertiary education programmes to early childhood development and primary education initiatives, where far more profound impacts can be achieved in the learning processes.

Anglo American Platinum's future community development initiatives and education investments should be designed in a more effective and intelligent manner, aligned to government planning and based on evidence, empirical research, recommendations and lessons emerging from grassroots stakeholders.

LESSONS LEARNT AND RECOMMENDATIONS

Based on the literature and fieldwork undertaken in Limpopo and North West, these are the recommendations for Anglo American Platinum's CED strategic planning and education programming going forward. Many of these suggestions can also apply to other mining houses and corporations engaged in supporting education and development in South Africa.

- Better co-ordination is needed between the company, education authorities and local stakeholders. Although the procurement of service providers can continue through the company, programme planning needs to occur in closer consultation with school principals and circuit and district managers. All private sector initiatives should be strongly aligned, synergised and integrated with the government's efforts and structures. More effective and sustainable changes in the education sector can occur only through government efforts, therefore small contributions from the private sector should be used to spur on and support systemic transformations and pilot innovation.

Science teacher in a physical sciences school lab in Limpopo

- Although the focus of companies is on improving education outcomes, there are often other complex psycho-social phenomena that need to be addressed at the same time. There is thus a need to engage more deeply with learners, parents and teachers in order to understand better and address more effectively the specific challenges facing communities. Education programmes thus need to be coupled with social development interventions and other community outreach efforts.
- Rather than dispersing resources and energies across a range of diverse initiatives, companies should rather focus on a few well-considered quality projects and implement them as best possible. Focus, for example, on fewer schools or fewer geographic locations, but try to integrate as many participants (ie, learners, teachers, management) as possible from the targeted schools in order to allow for a more visible and systemic impact.
- Learner-based interventions should not focus only on the high-performing learners, but rather assist all learners in the school. Enrichment camps and extra classes should be based on the knowledge gaps evident among the majority of learners in the school. If resources are limited, clear and fair criteria need to be set for participation in the programme.
- Overall literature and feedback from stakeholders in the field suggest that much more investment needs to be made in teacher development, as this is more sustainable and has greater long-term effects on the entire education system. Efforts need to go into upgrading teachers in both subject knowledge and innovative pedagogical methods. Corporate donors should carefully study the models on educator development available in South Africa and the two provinces (Mastec, Radmaste, RBI, Mpower, Dinaledi, etc.) and invest in those that produce the best results. Teacher training should also be accompanied by ongoing monitoring, on-the-job coaching, and the provision of high-end resources and teaching materials.
- Corporate investors should explore options on how to further encourage committed and hard-working educators by providing incentives such as prizes, awards and even financial bonuses for outstanding teachers who have good track records and show impressive improvement in their learners' performance. The assessment of educators must be fair and rigorous and incentives should be carefully studied so as not to lead to gaming or other negative effects. The Wits–SAIIA research team is happy to assist the companies in this endeavour by looking at international experiences, among others.
- The private sector should continue to invest in infrastructure, facilities and resources, as studies have proven that these can also have a positive effect if combined with interventions to improve teachers and school management.[66] One of the most useful inputs that mining companies could provide to all their schools is science and technology labs. These are fairly simple and relevant investments as they are also aligned to the company's comparative advantage and business niche. However, attention should be given to properly training educators to use these teaching aids and to regularly replenishing the science kits, as resources deplete over time.
- Although investment at the secondary school level, which is closer to the pipeline employment needs of the companies, is bound to continue, academic research suggests that a more profound impact on learning is achieved at lower grades and with younger age groups. Companies should therefore also invest at primary school level, and ensure

that learners are provided with strong foundations in maths and science in earlier grades, even before they reach FET schooling.

- Corporate social investments and education programmes must be planned based on evidence and rigorous research. Systematic and scientific monitoring and evaluation (M&E), including impact assessments and counterfactual evaluation, need to be imbedded in all interventions. M&E must be incorporated from the early design and thereafter in all the decision-making stages. Skilled staff and sufficient resources must be put aside to conduct solid research and M&E exercises for the purpose of constantly improving the companies' community engagement and development work.

FOLLOW-UP RESEARCH

A number of interesting issues have been uncovered in this research and could be explored in more depth in subsequent evaluations and academic studies. The research team recommends the follow-up and expansion of the current study in the short term to further investigate the following issues.

- Expanding the scope of the evaluation to include other Anglo American business units (Anglo Coal, De Beers, Kumba, Anglo American Chairman Fund, etc.), other mining companies (Lonmin, Impala, BHP Billiton, Rio Tinto, etc.) and other major corporations engaged in South Africa's education sector.
- A meta-analysis should be done comparing the impact and cost-effectiveness of all the empirical studies done thus far in South Africa on the interventions to improve learning outcomes in public schools, to identify which intervention produces the best results with the least amount of investment.
- Considering the key role of teachers in South Africa's education system, further quasi-experimental evaluations can be done on the following aspects:

    - Do schools with Zimbabwean and foreign teachers perform better than other schools?
    - Do the new educators who received university training post-2000 perform better than the educators who attended teacher-training colleges pre-1996?
    - Which model of in-service teacher training (RBI, Radmaste, Mastec, JET, Protec, Mpower, Dinaledi, Winning Team, Math Centre, CTLI, etc.) seems to have more sustainable impact on learning outcomes? Which approach appears to be more cost effective?[67]

- In light of the interesting results emerging from this study and as a follow-up to the highly debated 2010 World Bank impact evaluation, the Dinaledi school initiative should be re-visited, with a replicated impact assessment, using new and better data currently available, to see if the initial results have been sustained five years later.
- An investigation can be conducted into whether church-managed and religious schools in South Africa perform better than other public schools. If so, what are the underlying factors and motivations in these trends?

APPENDICES

Appendix 1: Stakeholders interviewed during qualitative fieldwork (schools visited are highlighted)

Name	Position	Institution	Province	District	Circuit/Area
Suzan Makalakala	CED Manager	Anglo Platinum	Limpopo	Waterberg	Magkalakwena
Tshepo Maphutse	CED Co-ordinator	Anglo Platinum	Limpopo	Waterberg	Thabazimbi
Peter	CED Co-ordinator	Anglo Platinum	N/A	N/A	N/A
Ntwana	CED Co-ordinator	Anglo Platinum	N/A	N/A	N/A
Charles Ntshabele	Communications Officer	Anglo Platinum	North West (NW)	Bojanala	Moses Khathane East
Joyce Mabe	CED Manager	Anglo Platinum	NW	Bojanala	Rustenburg
Benji Mokoka	CED Manager	Anglo Platinum	NW	Bojanala	Moses Khathane East
Mr Masizi	**School Principal**	**Boitikong Secondary School**	**NW**	**Bojanala**	**Rustenburg**
SS Makotanyane	Senior District Manager	Dept of Education (DOE)	Limpopo	Sekhukune	N/A
Dr Makola	Planning and Research Manager	DOE	Limpopo	N/A	N/A
Mr C Magkathe	Planning and Research	DOE	Limpopo	N/A	N/A
Mr Mhlongo	General Manager	DOE	Limpopo	N/A	N/A
Mrs MC Makhondo	General Manager	DOE	Limpopo	N/A	N/A
Dr Seopa	FET Manager	DOE	Limpopo	N/A	N/A
Ms Ita Armer	EMIS Manager	DOE	Limpopo	N/A	N/A
Mrs Madela	District Manager	DOE	Limpopo	Waterberg	N/A
Dr Sambo	Dinaledi Co-ordinator	DOE	Limpopo	N/A	N/A
Mr Malatji	Deputy Senior Manager	DOE	Limpopo	N/A	N/A
Pholwane	Circuit Manager	DOE	Limpopo	Sekhukune	N/A
MTD Manyane	Circuit Manager	DOE	Limpopo	Sekhukune	N/A
LA Lebopo	Circuit Manager	DOE	Limpopo	Sekhukune	N/A
IM Nkosi	Circuit Manager	DOE	Limpopo	Sekhukune	N/A
Ms Marifi	Circuit Manager	DOE	Limpopo	Waterberg	Magalakwena
Idah Matjiu	Circuit Manager	DOE	Limpopo	Capricorn	Mokgodumo
Mrs Ralefeta	Circuit Manager	DOE	Limpopo	Waterberg	Mapela
Mr Mphethe	Circuit Manager	DOE	Limpopo	Waterberg	Thabazimbi

Name	Position	Institution	Province	District	Circuit/Area
Mr Pheme	Circuit Manager	DOE	Limpopo	Capricorn	Lebowakgomo
Mr D Silman	Director Dinaledi	DOE	National	N/A	N/A
Mr A Tabane	Data Manager EMIS	DOE	National	N/A	N/A
Mr A Mokale	Data Manager EMIS	DOE	National	N/A	N/A
Mr Shongwe	Director EMIS	DOE	National	N/A	N/A
Ms G Poti	Quality Assurance	DOE	NW	N/A	N/A
Pauline Mkgutlhe	District Manager	DOE	NW	Bojanala	N/A
Mr Ntwape	Curriculum Manager	DOE	NW	Bojanala	N/A
Mrs V Leketi	Curriculum Advisor	DOE	NW	Bojanala	N/A
Mrs E Sebolai	Curriculum Advisor	DOE	NW	Bojanala	N/A
Ms Modi Mogotlane	Chief Education	DOE	NW	Bojanala	N/A
Mr Kekae	Area Manager	DOE	NW	Bojanala	Mokgwase
Mrs M Paledi	Area Manager	DOE	NW	Bojanala	Rustenburg
Tshoga Douglas	**School Principal**	**Ditsepu Secondary School**	**Limpopo**	**Capricorn**	**Malamulele Central**
N/A	**School Principal**	**Fields College**	**NW**	**Bojanala**	**Rustenburg**
Mrs Manganisa	**School Principal**	**Groen Vlei High School**	**Limpopo**	**Greater Sekhukhune**	**Lepelle**
N/A	**Deputy School Principal**	**Hoërskool Frikkie Meyer**	**Limpopo**	**Waterberg**	**Thabazimbi**
N/A	Organiser	Hoërskool Frikkie Meyer	Limpopo	Waterberg	Thabazimbi
Mr KS Nair	**School Principal**	**Holy Family**	**NW**	**Bojanala**	**Moses Khathane East**
Dr Opperman	Education Project Manager	Impala	NW	Bojanala	Rustenburg
Blackie Swart	CSI Manager	Impala	NW	Bojanala	Rustenburg
Mr Al Tsomakae	**School Principal**	**JM Ntsime High School**	**NW**	**Bojanala**	**Moses Khathane East**
Mrs Phatudi	**School Principal**	**Leshikishiki Secondary School**	**Limpopo**	**Capricorn**	**Tshilamba**
Mrs C Clark	CSI Manager	Lonmin	NW	Bojanala	Marikana
Mr Lesego Mokgale	CSI Co-ordinator	Lonmin	NW	N/A	N/A
Napo M Frank	**School Principal**	**Mabokgopedi Secondary School**	**Limpopo**	**Sekhukune**	**Magakala**
Mr Musi	Deputy School Principal	Mabokgopedi Secondary School	Limpopo	Greater Sekhukhune	Mmashadi
Kgwabane	HOD Math & Science	Mabokgopedi Secondary School	Limpopo	Greater Sekhukhune	Mmashadi

Name	Position	Institution	Province	District	Circuit/Area
LL Tlhotse	**School Principal**	**Madikwe High School**	**Limpopo**	**Capricorn**	**Tshilamba**
N/A	**School Principal**	**Mahwibitswane High**	**Limpopo**	**Capricorn**	**Mokgodumo**
N/A	**School Principal**	**Makgamathu Secondary School**	**Limpopo**	**Sekhukune**	**Driekop**
Ngoepe	**School Principal**	**Makgenene High School**	**Limpopo**	**Mopani**	**Nsami**
N/A	**School Principal**	**Makuka Secondary School**	**NW**	**Bojanala**	**Moses Khathane East**
Prof. Matamba	Director	Mastec	Limpopo	N/A	N/A
N/A	Curriculum Manager	Mastec	Limpopo	N/A	N/A
N/A	Trainer	Mastec	Limpopo	N/A	N/A
N/A	Research & Evaluation	Mastec	Limpopo	N/A	N/A
MS Ribane	**School Principal**	**Mahlogedi Secondary School**	**Limpopo**	**Capricorn**	**Mogodomo**
C Monkwe	**School Principal**	**Matsibe High School**	**Limpopo**	**Mopani**	**Shamavhunga**
N/A	**School Principal**	**Mmakopi Secondary School**	**Limpopo**	**Greater Sekhukhune**	**Lepelle**
Matjeke	**Deputy School Principal**	**Mmatanta Secondary School**	**Limpopo**	**Greater Sekhukhuni**	**Hlogotlou**
Dr Sello	CEO	Protec	National	N/A	N/A
Mr F Mutamba	Programme Director	Protec	National	N/A	N/A
Ms B Hattingh	Director	Radical Math	National	N/A	N/A
Prof. John Branley	Director	Radmaste	National	N/A	N/A
Ian Mclachian	CEO	RBI	NW	Bojanala	Rustenburg
Mr Y Ebrahim	CEO	Star Schools	National	N/A	N/A
LM Letaha	**School Principal**	**Thete High School**	**NW**	**Bojanala**	**Rustenburg**
NN Thlohane	**School Principal**	**Thogoa High School**	**Limpopo**	**Capricorn**	**Mogodomo**
MS Ribane	HOD Math & Science	Thogoa High School	Limpopo	Capricorn	Mogodomo
N/A	**School Principal**	**Tlhabane Tech High School**	**NW**	**Bojanala**	**Rustenburg**
Mr P Mokilane	Statistician	Umalusi	National	N/A	N/A
Ms P Mosemola	Junior Statistician	Umalusi	National	N/A	N/A
Mr E Sibanda	Director of Statistics	Umalusi	National	N/A	N/A
J Kekana	**Deputy School Principal**		**Limpopo**		

Source: Author's own compilation, 2013

Appendix 2: Maths and science FET-level interventions implemented in North West and Limpopo between 2008 and 2013

1	Initiatives funded and organised by **national** or **provincial Departments of Education**: a Mastec Teacher Development Centre, running intensive in-service training for educators across Limpopo. b University of Pretoria training of principals in North West. c GLIP/Girl Child Saturday classes for grade 12 female North West learners in life skills, maths and science. d Many schools, circuits and districts would organise their own Saturday and holiday camps for grade 12 learners to address the content gaps and prepare them for the NSC exam. e 'Last Push' systematic revision of exam question papers for grade 12 North West learners in 2013. f Learner Attainment Improvement Plan (LAIP), monitoring curriculum implementation in North West. g QIDS-UP initiative by the national Department of Basic Education (DBE) in 2006, providing resources, computers, and maths and science kits to practically all senior and intermediate schools in the country. h Dinaledi schools – flagship programme of the national DBE to provide well-performing, poor schools with additional teachers, educator training, equipment and resources for maths and science, rolled out in 46 secondary schools in North West and 51 secondary schools in Limpopo.
2	**Mayor of Rustenburg** special programme for 11 low-performing schools in the municipality, as well as a School of Excellence for high-achieving learners in the city.
3	**Impala Platinum** interventions, including teacher training in four schools in Rustenburg and revision courses and infrastructure support around Marula mine in Sekhukhune.
4	**Lonmin** support to four schools in Marikana (North West) and eight schools in Lebowagomo circuit in Limpopo.
5	**Bokone Mine** winter enrichment programme for FET leaners held in 2012 and 2013.
6	Bojanala systematic training/coaching of teachers run by **JET** from 2009–2013 in 25 schools.
7	**RBI** support to 43 schools in its area, including a school feeding programme, rehabilitation of toilets, educator development and school management and governance programme. Scholarships for Bafokeng youth to study at Lebone private college.
8	**Kumba Mine** support to schools around Thabazimbim, including: • Development of teachers and school management by Mpower in 2012. • Saturday schools and holiday camps for grade 8 and 10 learners implemented in 2013. • Educator and management training by UNISA. • Upgrading of all schools with science labs in 2010. • Provision of university bursaries to learners from the mining area.

9	**Thabazimbi Community Forum (TCF)**, which holds a 15% share in Sishen Iron Ore Company Community Development Trust (SIOC-cdt) towards which Kumba proceeds also go, runs very successful social programmes in Thabazimbi communities, which include: • Renovation of Mabogopedi Secondary. • Evening and weekend classes for learners, educator training, and the provision of additional educators by maths and science NGO Sangari. • Winter schools for all grade 12 learners implemented by Impatla Atsane.
10	The NGO **Math Centre** works with educators as well as grade 11 and 12 learners through Saturday and afternoon classes.
11	**Protec** programmes for educators as well as learners implemented in both Limpopo and North West, funded by various **private companies**.
12	**Dikateleng** and **North West University** programme for grade 12 learners implemented throughout the North West in 2012 and 2013.
13	**Star Schools** supplementary classes for grade 12 learners in North West and Limpopo, funded by **Rainbow Chicken** and Anglo American.
14	**Pearl-Edu Vision** programme implemented in Limpopo in 2009.
15	**Experico's Foundation for Learning**, a very successful primary school programme also funded by Anglo American Platinum, which also had repercussions at secondary level. The programme ended in 2010 due to pressures from teachers and unions.
16	Other initiatives by **mines** such as **Xstrata, ASA Metal, Two Rivers, De Beers** and **Sabanku**, usually consisting of the provision of infrastructure, textbooks, computers and bursaries.
17	**Standard Bank**'s **Winning Team** programme for teacher training implemented in Limpopo in 2013.
18	**Meropa and Sun City** casinos' interventions, often building or refurbishing schools.
19	**Zennex Foundation**'s whole school programmes to address language, maths and science learning outcomes in four secondary schools in Vhembe district, implemented via **Mpower, CASME, SLCA, TEN, IMSTUS** and **SUPEDI**.
20	Other **small corporate initiatives** in North West and Limpopo such as those of **MTN, Sanlam, Old Mutual** and **Cell C**.

Source: Author's own compilation, 2013.

Appendix 3: Intervention variables used in the study

Variable name	Type	Explanation
Anglo_ScienceLab	Dummy	If the school received science lab and equipment from Anglo American Platinum
Anglo_Computers	Dummy	If the school received computers and an ICT lab from Anglo American Platinum
Anglo_Other_infrast	Dummy	If the school received any other infrastructure support from Anglo American Platinum
Anglo_Star_Schools	Scale	Number of learners who participated in the Anglo/Star School Saturday schools in 2011
Anglo_Radmaste_TT	Scale	Number of educators who participated in the Anglo/ Radmaste teacher training
Anglo_Radical_2008	Scale	Number of learners who participated in the Anglo/Radical Math & Science A-Team programme in 2008
Anglo_Radical_2009	Scale	Number of learners who participated in the Anglo/Radical Math & Science A-Team programme in 2009
Anglo_Radical_2010	Scale	Number of learners who participated in the Anglo/Radical Math & Science A-Team programme in 2010
Anglo_ winterschool_2011	Scale	Number of learners who participated in the Anglo/Radical Math & Science winter revision camp in 2011
Anglo_ winterschool_2012	Scale	Number of learners who participated in the Anglo/Radical Math & Science winter revision camp in 2012
AngloYes	Dummy	Dummy variable indicating that the school received one of the above or any type of assistance and support from Anglo American Platinum
Dinaledi	Dummy	The school is a Dinaledi school
Mastec	Scale	Number of educators who participated in Mastec teacher training
RoyalBafokeng	Dummy	School received treatment from RBI
Etc ...	Dummy	School received intervention X ...
Any_Intervention_YES	Dummy	Indicating if the school received any intervention from any institution between 2008 and 2012

Source: Author's own compilation, 2013

Appendix 4: Outcome variables used in the study

Variable name	Explanation
Overall_Passes_2008	% of learners passing the NSC exam in 2008
Bachelor_ Passes_2008	% of learners passing the NSC with a pass that allows entry into university
Math_Enrol_2008	% of learners registered in the NSC taking maths as a subject
Math_Passes_2008	% of learners passing maths above 30% mark
Math_Excel_2008	% of learners passing maths above 50% mark
Physics_Enrol_2008	% of learners registered in the NSC taking physics as a subject
Physics_Passes_2008	% of learners passing physical sciences above 30% mark
Physics_Excel_2008	% of learners passing physical sciences above 50% mark
English_Passes_2008	% of learners passing English (first additional language) above 30% mark
English_Excel_2008	% of learners passing English (first additional language) above 50% mark
Overall_Passes_2012	% of learners passing the NSC exam in 2012
Bachelor_ Passes_2012	% of learners passing the NSC with a pass that allows entry into university
Math_Enrol_2012	% of learners registered in the NSC taking maths as a subject
Math_Passes_2012	% of learners passing maths above 30% mark
Math_Excel_2012	% of learners passing maths above 50% mark
Physics_Enrol_2012	% of learners registered in the NSC taking physics as a subject
Physics_Passes_2012	% of learners passing physical sciences above 30% mark
Physics_Excel_2012	% of learners passing physical sciences above 50% mark
English_Passes_2012	% of learners passing English (first additional language) above 30% mark
English_Excel_2012	% of learners passing English (first additional language) above 50% mark

Source: Author's own compilation, 2013

Appendix 5: Explanatory variables used in the study

Name	Type	Explanation and notes
NatEMIS	Nominal	Unique school ID number used to linked datasets together
School_name	Nominal	Name of institution
Province	Nominal	Province where school is situated
District	Nominal	District municipality where school is situated
Circuit	Nominal	Circuit where school is situated (this changed over the years, therefore data from 2010 was used)
GIS_latitude	Scale	Latitude of school's GIS co-ordinate
GIS_longitude	Scale	Longitude of school's GIS co-ordinate
Quintile	Ordinal	Coded as 1, 2, 3, 4 and 5, reflecting the socio-economic status of the school with 1 being the poorest and 5 the richest
Section_21	Dummy	Indicates a type of advanced status and autonomy of school (this variable was eventually taken out as the original data indicated that all Limpopo schools are section 21, therefore not a useful variable and probably suffering from transcription errors)
Urban_Rural	Dummy	Indicates the location of a school in relationship to urban or rural areas (this variable was eventually taken out as most of the data was missing or incomplete)
FeeORnot	Dummy	Indicating if the school is a 'no fee school'
AverageFees	Scale	Average yearly fees charged by school for grades 10, 11 and 12
SchoolType	Dummy	Indicating if the school is public or private
Specialisation	Ordinal	Coded as 6 = Technical; 5 = Commercial; 4 = Comprehensive; 3 = Ordinary; 2 = Agriculture; 1 = Arts
Land_ownership	Dummy	Indicating if the school is on privately owned land
Building_ownership	Dummy	Indicating if the school is in a privately owned building
Bantustan_Yes	Dummy	Indicating if the school used to fall under previous homeland administration
Total_Learners	Scale	Total number of learners in grades 10, 11 and 12
EngAfr_HLang_ learners	Scale	% of learners whose home language is English or Afrikaans
Per_black_learners	Scale	% of learners who are black and other HDSA racial groups
Av_Learners_ Disable	Scale	Average number of learners with academic disabilities in grades 10, 11 and 12
Av_Pregnancies	Scale	Average number of learners who fell pregnant in grades 10, 11 and 12 (eventually this variable dropped out of the analysis as it was not considered to be useful)
Learner_repeaters	Scale	Number of learners repeating grades 10, 11 and 12 (eventually this variable dropped out of the analysis as it was not considered to be useful)
Learner_dropouts	Scale	Number of learners dropping out of grades 10, 11 and 12 (eventually this variable dropped out of the analysis as it was not considered to be useful)
Total_Educators	Scale	Total number of educators in grades 10, 11 and 12
Learner-Educator_ ratio	Scale	Number of learners divided by number of educators

Name	Type	Explanation and notes
Total_MST_ Educators	Scale	Number of educators dedicated to maths, science and technology
Percent_MST_ Educators	Scale	% of educators dedicated to the teaching of maths, science and technology from the total number of educators in the school
Learner-MSTedu_ ratio	Scale	Ratio of maths, science and technology educators available to total number of learners in the school
PercAcDegree	Scale	% of educators with a university degree
Edu_exper_<15	Scale	Number of educators with fewer than 15 years of work experience
Edu_exper_>15	Scale	Number of educators with more than 15 years of work experience
Perc_Young_Edu	Scale	% of educators with fewer than 15 years of work experience from total number of educators
Perc_Old_Edu	Scale	% of educators with more than 15 years of work experience from total number of educators
Total_Foreign_ MSTedu	Scale	Total number of foreign (ie, Zimbabwean) educators teaching maths, science and technology subjects
Per_Foreign_ MSTedu	Scale	% foreign (ie, Zimbabwean) educators teaching maths, science and technology subjects
Foreign_Educ_Yes	Dummy	Indicating if the school uses foreign (ie, Zimbabwean) educators
Science_Lab	Dummy	If a science lab is present in the school
Computer_Lab	Dummy	If an ICT lab is present in the school
Media_Library	Dummy	If a media library is present in the school
Multi-group_class	Dummy	School in which more than one class group need to share one classroom
SGB_approved Curriculum	Dummy	School with a curriculum approved by SGB
Time_tables	Dummy	School with timetables available
Curriculum_Plan	Dummy	School with curriculum plan available
Curriculum_Test	Dummy	School with regular learning assessments available
Curriculum_ Monitoring	Dummy	School with ongoing curriculum coverage monitoring
qualityofMaths	Dummy	School with access to quality maths programme
qualityofScience	Dummy	School with access to quality science programme
Integrate_ICT	Dummy	Integration of ICT facilities in teaching process
Teaching_aids	Dummy	Availability of teaching aids for educators
Distance_Mine*	Scale	Calculated using the GIS co-ordinates of the school and the platinum mine using haversin formula
50km_from_Mine*	Dummy	Dummy variable indicating if school is within 50km from platinum mine (calculated using the distance from mine variable above)
District_Location*	Dummy	Each of the district municipalities of North West and Limpopo was converted into a dummy variable, namely Greaterdelareyville, Greatertaung, Kagisanomolopo, Kgetlengriver, Lebowakgomo, Lichtenburg, Madibeng, Mafikeng, Maquassihills, Matlosana, Mogalakwena, Mopani, Moretele, Moseskotaneeast, Capricorn, Potchefstroom, Polokwane, Sekhukhune, Rustnburg, Taledi, Vhembe, Waterberg and Zeerust.

Source: Author's own compilation, 2013

Appendix 6: Percentage of learners in treated schools writing the 2012 NSC exam who also attended the 2012 Anglo winter schools

Province	Institute	District	Circuit	% of learners writing NSC exam	% of learners writing maths at NSC exam	% of learners writing physics at NSC exam
NW	Gaopotlake Senior Secondary School	Moses Kotane East	Kgabo Kwena	31	87	93
NW	Kgalatlowe High School	Moses Kotane East	Kwena	65	100	100
NW	Kwenatlase	Moses Kotane East	Mpgale	35	100	100
LP	Mabogopeli High	Waterberg	Thabazimbi	43	100	80
LP	Langalibalele Secondary	Waterberg	Mapela	51	100	100
LP	Makgenene High	Waterberg	Mapela	3	6	6
LP	Maleya Senior Secondary	Waterberg	Mapela	11	43	33
LP	Mantata Secondary		Mapela	52	82	85
LP	MC Langa Secondary	Waterberg	Mapela	8	29	15
LP	Mmantutule Secondary	Waterberg	Mapela	40	51	77
LP	Mmatadu Secondary	Waterberg	Mapela	71	94	94
LP	Mphunye Senior Secondary	Waterberg	Mapela	37	84	84
LP	Sekoba Secondary	Waterberg	Mapela	18	40	40
LP	Serirarita Secondary	Waterberg	Mapela	47	54	54
LP	Tjitjila Secondary	Waterberg	Mapela	5	22	13
LP	OR Mabotja Secondary	Capricorn	Seshego	14	100	78
LP	Mafolofolo High	Capricorn	Dimamo	46	65	88
LP	Boikhutsong Senior Secondary	Capricorn	Mogodumo	22	50	60
LP	Leshikishiki High	Capricorn	Mogodumo	3	5	5
LP	Mahlogedi Secondary	Capricorn	Mogodumo	71	100	100
LP	Mahwibitswane Secondary	Capricorn	Mogodumo	24	80	95
LP	Radikgomo Secondary	Capricorn	Mogodumo	27	75	75
LP	Sehlola High	Capricorn	Mogodumo	20	75	75
LP	Thogoa Secondary	Capricorn	Mogodumo	7	17	17
LP	Tshehlo High	Capricorn	Mogodumo	30	43	55
LP	Shorwane Secondary	Greater Sekhukhune	Ngwaabe	31	67	67
LP	Gangadza Secondary	Greater Sekhukhune	Dilokong	100	100	100
LP	Lesailane Secondary	Greater Sekhukhune	Dilokong	66	92	92
LP	Tekanang Secondary	Greater Sekhukhune	Moroke	42	100	100
LP	Tshihlo Secondary	Greater Sekhukhune	Moroke	43	100	100
LP	Makopi Senior Secondary	Greater Sekhukhune	Driekop	43	100	100
LP	Makgwale Secondary	Greater Sekhukhune	Ngwaabe	20	91	91
LP	Nqwanangwato Secondary	Greater Sekhukhune	Ngwaabe	22	33	79
LP	Ntotwane Secondary	Greater Sekhukhune	Ngwaabe	35	100	65

Province	Institute	District	Circuit	% of learners writing NSC exam	% of learners writing maths at NSC exam	% of learners writing physics at NSC exam
LP	Sengange Senior Secondary	Greater Sekhukhune	Ngwaabe	47	94	100
LP	Gobetse Secondary	Greater Sekhukhune	Ngwaabe	23	90	100
LP	Itireleng Secondary	Waterberg	Vaalwater	10	100	100
				Mean	Mean	Mean
				37	72	73

Source: Author's own compilation, 2013

ENDNOTES

1 Three-letter currency code for the South African Rand.

2 Chamber of Mines of South Africa, Facts and Figures 2012, Johannesburg: Chamber of Mines of South Africa, 2013, http://www.bullion.org.za/documents/Chamber%20facts%20and%20figures%202013.pdf.

3 Ashman S, 'Political economy of platinum', paper presented at conference on The Meaning of the Rise of the South African Platinum Mining Industry and the Nature of the Post-Apartheid Order, Johannesburg: Corporate Strategy and Industrial Development, March 2013.

4 Capps G, 'Contrasting configurations of platinum capital and tribal authority: Bafokeng, Bengwenyama and Langa Mapela (Johannesburg vol.)', paper presented at the conference on The Meaning of the Rise of the South African Platinum Mining Industry and the Nature of the Post-Apartheid Order, Johannesburg, October 2013.

5 Chamber of Mines, *op. cit.*

6 Capps G, *op. cit.*

7 Ashman S, *op. cit.*

8 Benkenstein A, *The Platinum Sector Peace and Stability Accord: Solution or Reprieve*. Cape Town: South African Institute of International Affairs, 2013.

9 See Chambers of Mines, *op. cit.*

10 See Capps G, *op. cit.*

11 See South Africa, Black Economic Empowerment Act 2003. Pretoria: Government Printer, 2003.

12 Trialogue, *The CSI Handbook 2012*. Cape Town: Trialogue, 2012.

13 Besharati N, *Private Sector Investment in South Africa's Education Sector: Nature, Extent and Incentives*. London: Overseas Development Institute, 2013.

14 Besharati N, *SADPA: Strategic Aid of Development Packages for Africa?,* Research Report 15. Johannesburg: South African Institute of International Affairs, 2013.

15 Hodgson J, electronic conversation, Johannesburg, 2014.

16 Schollar E, *Final Report: The Primary Mathematics Research Project 2004–2007, Towards Evidence-based Educational Development in South Africa*. Johannesburg: Eric Schollar and Associates, February 2008.

Before 2008, the secondary school National Senior Certificate (NSC) examination was called the Senior Certificate (SC) examination or, informally, the 'matric exam'. Most subjects, including maths, were passed at either Standard Grade (SG) or Higher Grade (HG) level. In the new NSC system post-2007, this was converted into Math Literacy (generally a lower standard) and Pure Mathematics (considered a higher standard). Passes in the latter are normally required in order to enroll in university courses in commerce, engineering and scientific subjects.

17 Mabe J, *Education Review Presentation (2009–2012): Education & Skills Development*. Johannesburg: 2012.

18 See, for instance, Bloom H *et al.*, 'Performance trajectories and performance gaps as achievement effect-size benchmarks for education interventions', *Journal of Research on Educational Effectiveness*, 1, 2008, pp. 289–328.

19 Hunt K *et al.*, 'A blurred signal? Comparability of NSC mathematics scores and former SC

34 Lipsey M & D Wilson, *Practical Meta-Analysis* (vol. 49). Thousand Oaks: Sage Publications, 2001.

35 Campbell Collaboration, Practical Meta-Analysis Effect Size Calculator, 2013, http://www.campbellcollaboration.org/resources/effect_size_input.php.

36 Cohen J, *Statistical Power Analysis for the Behavioral Sciences* (2nd ed). Hillsdale: Lawrence Eribaum, 1988; and Lipsey M, *Design Sensitivity: Statistical Power for Experimental Research* (vol. 19). Newbury Park: Sage Publications, 1990.

37 Coe R, 'It's the effect size, stupid: What effect size is and why it is important', 2002, http://www.leeds.ac.uk/educol/documents/00002182.htm.

38 Hattie J, *Visible Learning: A Synthesis of Over 800 Meta-analyses Relating to Achievement*. London: Routledge, 2012.

39 Lipsey M, *op. cit*.

40 Anglo American Platinum had, for example, constructed Mahlogedi, a new school in Capricorn. As part of the project, a science lab was built in 2007, but it remained locked until 2013 when the principal managed to force it open. The lab room and furniture were pristine, but the water and gas system, essential to scientific experiments, was not working, thus making the lab usable only as an extra study room.

41 Direct quote of some of the school principals and circuit managers interviewed in Limpopo, October 2014.

42 Direct quote of a school principal interviewed in Limpopo, October 2014.

43 Various authors contributed to the literature, for example Kremer *et al*., *The Challenge of Education and Learning in the Developing World*. Boston: Harvard University, 2013; and Taylor N, *The National School Effectiveness Study (NSES): Summary for the Synthesis Report*. Johannesburg: JET Education Services, 2011.

44 See Simkins C, *Maths and Science Performance of South Africa's Public Schools*. Johannesburg: University of the Witwatersrand, 2011; Taylor N, *A Five-year Plan for South African Schooling: A Report Commissioned by the National Planning Commission*. Johannesburg: JET Education Services, 2011; and Christie P, Butler D & M Potterton, *Schools that Work. Report to the Minister of Education*. Pretoria: SA Department of Education, 2007.

45 Taylor S & M Coetzee, *Estimating the Impact of Language of Instruction in South African Primary Schools: A Fixed Effects Approach*. Stellenbosch: Stellenbosch University, 2013; Cummins J, Multilingualism in the English-language classroom: pedagogical considerations, *TESOL Quarterly*, 43, 2, 2009, pp. 317–321; Kaphesi E, *Effects of Home Language on Pupils' Performance in Mathematics*. London: British Society for Research into Learning Mathematics, 2001;

46 Van der Berg S, 'How Effective Are Poor Schools? Poverty and Educational Outcomes in South Africa', CEGE Discussion Papers, 69, 2008.

47 See, among others, Taylor N, *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice*. London: Taylor and Francis, 2009; Taylor S, 'The impact of study guides on matric performance: Evidence from a randomised experiment', paper presented at the Economic Society for South Africa, Bloemfontein, 2013; Spaull N, 'A Preliminary Analysis of SACMEQ III South Africa', Stellenbosch Economic Working Papers, 11/11; CDE (Centre for Development and Enterprise), *Value in the Classroom: The Quantity and Quality of South Africa's Teachers*. Johannesburg: CDE, September 2011; and Gustafsson M, 'Using the Hierarchical Linear Model to Understand School Production in South Africa', Stellenbosch Economic Working Papers, 7, 1, 2007.

mathematics scores: How consistent is the signal across time?', *Education as Change*, 15, 1, 2011, pp. 3–16.

20 The Dinaledi programme is a flagship programme of the national Department of Education, aimed at improving science passes at the senior certificate exams, through supporting targeted well-performing public schools with the provision of additional teachers, training programmes and learning and teaching materials. The programme started in 2004 and now engages over 500 schools throughout the country. Private sector partners have also been mobilised to support this national education initiative.

21 Besharati N, 'Evaluation Model and Methodology Framework'. Johannesburg: University of the Witwatersrand (unpublished), 2012a.

22 *Ibid.*

23 When a meeting is held under the Chatham House Rules, participants are free to use the information received from the meeting, but neither the identity nor the affiliation of the speaker/participant/informant may be revealed when quoted.

24 Bantustan states or 'homelands' were self-governing black territories within South Africa created by the apartheid administration, though not legally recognised by the international community.

25 Stand J, 'The 'Hawthorne effect' – what did the original Hawthorne studies actually show?', *Work Environ Health*, 26, 4, 2000, pp. 363–367.

26 The 'Hawthorne effect' and 'John Henry effect' are some of the socio-psychological phenomena where groups behave differently when they are being observed. This can manifest itself in reactive behaviour, compensatory rivalry, resentful demoralisation and participants 'working harder' to prove themselves better than the other group. See Saretsky G, 'The OEO PC experiment and the John Henry effect', *The Phi Delta Kappan*, 53, 9, 1972, pp. 579–581.

27 See, for instance, Besharati N, 2012a, *op. cit.*

28 Cook TD & WR Shadish, 'The renaissance of field experimentation in evaluating interventions', *Annual Review of Psychology*, 60, 2009, pp. 607–629, http://scholar.google.co.za/scholar?hl=en&q=shadish%2Ccook+2009&btnG=&as_sdt=1%2C5&as; and Dehejia RH & W Sadek, *Causal Effects in Non-experimental Studies: Re-evaluating the Evaluation of Training Programs*, 1999. Columbia: Columbia University and Morgan Stanley, 1999, pp. 1053–1062.

29 See World Bank, 'Expanding Opportunities for South African Youth Through Math and Science: The Impact of the Dinaledi Programme'. DIME brief, Washington DC: World Bank, 2010.

30 See, for instance Jalan J & M Ravallion, 'Does piped water reduce diarrhea for children in rural India?', *Journal of Econometrics*, 112, 1, 2003, pp. 153–173; and Dearden L *et al.*, *Education Subsidies and School Drop-out Rates*. London: Institute for Fiscal Studies, 2008.

31 Glewwe P, 'Practical Advice for Implementing Randomized Evaluations', lecture at the CLEAR-AA Course: How to Design, Manage and Conduct Impact Evaluations, Johannesburg, July 2012.

32 Lipsey MW *et al.*, *Translating the Statistical Representation of the Effects of Education Interventions into More Readily Interpretable Forms (NCSER 2013–3000)*. Washington, DC: National Center for Special Education Research, Institute of Education Sciences, US Department of Education, http://ies.ed.gov/ncser/; and Becker BJ & M Wu, *The Synthesis of Regression Slopes in Meta-Analysis*, 22. Beachwood: Institute of Mathematical Statistics, 2007.

33 Hombrados J & H Waddington, 'Risk of Bias Assessment for Experimental and Quasi-experimental Designs Based on Statistical Methods', presentation at the 3rd Systematic Review International Symposium, Dhaka, 2012.

48 Blum J, Krishnan N & A Legovini, *Expanding Opportunities for South African Youth through Math & Science: The Impact of the Dinaledi Program*. Washington, DC: World Bank Development Impact Evaluation Initiative (DIME), 2010.

49 A similar finding also emerged from the World Bank (*ibid.*) impact evaluation of the Dinaledi initiative, which showed that schools in former Bantustan areas performed better than schools under former House of Assembly administration.

50 See, for instance, Besharati N, 2012a, *op. cit.*

51 These include sgbApprovedCurriculum curriculumAvailable timeTable curriculumPlan curriculumTest implementationSystems accesstoMaths qualityofMaths accesstoScience qualityofScience integrateICT educatorAssistance_.

52 These include Greaterdelareyville, Greatertaung, Kagisanomolopo, Kgetlengriver, Lebowakgomo, Lichtenburg Madibeng, Mafikeng, Maquassihills, Matlosana, Mogalakwena, Mopani, Moretele, Moseskotaneeast, Capricorn, Potchefstroom, Polokwane, Sekhukhune, Rustenburg, Taledi, Vhembe, Waterberg, Zeerust.

53 Used only in the next PSM on the impact of the Anglo programme.

54 See Cohen J, *op. cit.*; and Lipsey M & D Wilson, *op. cit.*

55 Aside from maths and physical sciences, life sciences and geography were also taught and tested at the 2012 Winter Camp.

56 Radical Math & Science, *Report Winter School Camp 2012*. Johannesburg: Retque 201 cc, 2012.

57 Programme data was made available by Radical Math & Science and NSC exam enrolment data was provided by Umalusi.

58 The research team divided the numbers of educators trained by Radmaste by the total number of maths, science and technology (MST) teachers recorded by each school in that year through the Department of Education's EMIS system, although data for some of the schools was missing.

59 Mosley P, 'Aid-effectiveness: The micro-macro paradox', *IDS Bulletin*, 17, 2, 1984, pp. 22 & 27.

60 Boone P, 'Politics and the effectiveness of foreign aid', *European Economic Review*, 40, 2, 1996, pp. 289–329.

61 Picciotto R, *Development Effectiveness at the Country Level*. Bonn: German Development Institute, 2006.

62 See Besharati N, 2012a, *op. cit.*

63 Riddell R, *Foreign Aid Reconsidered*. Baltimore: Johns Hopkins University Press, 1987; Roche C & L Kelly, 'Evaluating the performance of development agencies: Perspectives from NGO experience', in GK Pitman, ON Feinstein, & G; Kruse S, 'Searching for impact and methods: Meta-evaluations of NGO experience', paper presented at the Fifth Biennial World Bank Conference on Evaluation and Development 'Evaluating Development Effectiveness: Challenges and the Way Forward', in Washington DC, 2003; and Masud N & B Yontcheva, *Does Foreign Aid Reduce Poverty?: Empirical Evidence from Nongovernmental and Bilateral aid*. International Monetary Fund, 2005.

64 Lipsey M *et al.*, *op. cit.*

65 Stand J, *op. cit.*

66 Glewwe P, 'The impact of child health and nutrition on education in less developed countries', *Handbook of Development Economics*. Amsterdam: North Holland, 2007.

67 Considering how recently these educator development programmes were implemented, it would be sensible to conduct the comparative analysis using the 2013 NSC exam results as soon as they are made available.

SAIIA'S FUNDING PROFILE

SAIIA raises funds from governments, charitable foundations, companies and individual donors. Our work is currently being funded by, among others, the Bradlow Foundation, the UK's Department for International Development, the European Commission, the British High Commission of South Africa, the Finnish Ministry for Foreign Affairs, the International Institute for Sustainable Development, INWENT, the Konrad Adenauer Foundation, the Royal Norwegian Ministry of Foreign Affairs, the Royal Danish Ministry of Foreign Affairs, the Royal Netherlands Ministry of Foreign Affairs, the Swedish International Development Cooperation Agency, the Canadian International Development Agency, the Organisation for Economic Co-operation and Development, the United Nations Conference on Trade and Development, the United Nations Economic Commission for Africa, the African Development Bank, and the Open Society Foundation for South Africa. SAIIA's corporate membership is drawn from the South African private sector and international businesses with an interest in Africa. In addition, SAIIA has a substantial number of international diplomatic and mainly South African institutional members.

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