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Exploring the root cause of poor performance in Maths and Science education and the impact to the South African economy

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Abstract

The South African economy is not competitive in the global context. The inadequate number of skilled people in the Maths and Science arena is central to the structural unemployment and limited growth prospects in certain sectors such as manufacturing, technology and engineering. The big question is why? The answer is poor performance in Maths and Science at the school level. Maths and Science is a critical element towards economic recovery, especially in an ever increasing competitive global environment. It stimulates economic equality and opportunity for all whilst eliminating the disparities in the skills shortage and reducing adverse poverty.

This study is aimed at discovering the root cause of poor performance in Maths and Science education, Secondly to explore the interaction between the poor performance and economic performance and lastly to use the vicious cycle of poverty study to enhance the research and provide more insight into the dynamics of the problem.

The research was informed by the principles of qualitative methodology. The reasons for the poor performance were given by past learners of Maths and Science and the impact to the South African economy given by specialists. The interaction of the two was used to create a model incorporating all the learning.

Keywords: root cause, poor performance, Maths and Science, economic impact

Declaration

I declare that this research project is my own work. It is submitted in partial fulfillment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria.

It has not been submitted before for any degree or examination in any other University.

I further declare that I have obtained the necessary authorization and consent to carry out this research.

Bridget Banda

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"*Physics, chemistry and mathematics form the basis for many Scientific or technological applications and discoveries, and as innovation and technological advancement are the driving force behind today's globally competitive economy, it makes good career sense to gain the versatile skills an enabling science degree will award you*."

Professor Bruce Milthorpe

CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1. Introduction

Maths and Science is a driving force of a strong performing economy, it is a key area of knowledge whose competency is necessary for individual and economic development and it is also an important factor of global competitiveness especially in a world of rapid technological changes (Tatira, Mutambara & Chagwiza, 2012). McGrath and Akoojee (2007) further added that the rationale in focusing on education is that it's crucial for competitiveness, they emphasize that education should be a core objective in the South African national development strategy, to enable competitiveness in globalisation and the knowledge economy.

The twentieth century has seen education rise above the ranks as a base for social economic development and as a prime influential factor of a countries level of wealth by being able to alleviate poverty, increase the workforce and stimulate intellectual flexibility among its societies (Ozturk, 2001). The research seeks to act as a point of reference or set a standard for the Department of education, the heads of governing bodies and the teacher union and institutes whose role is primarily the execution of policies and strategic action planning within the education system, specifically in the Maths and Science arena.

Whilst Human capital investment within a country draws in different skills which are highly valuable due to the impact it has on the vital parts of everyday life. Skills in Maths and Science are the most crucial for social and economic welfare, typical examples include important career streams in the life sciences, behavioural and social sciences, earth and environmental sciences, math and computer sciences, engineering, interdisciplinary and physical sciences (Ozturk, 2001).

Education aspires nation building and promotes interpersonal tolerance due to its integration nature hence Societies are able to transcend beyond cultural and national

boundaries due to the advantages and assurances that education brings, especially Maths and science (Romagnolo & Anderson, 2010).

1.2 Background to the study

1.2.1 The State of Maths and Science in South Africa

In Sub-Saharan Africa about 1% of GNP (Gross National Product) is spent on Science, technology and development, this amount is comparatively low, compared to developed countries (Govender and Gruzd, 2011), although South Africa's expenditure on education and training is more than most developed countries especially in the last four decades. The result show a growth of 48 million in embedded human capital in Africa from 1960 to 230 million in 1996 (Measured in completed school cycle), the downfall is the quality of the education (Simkins, 2011).

The issues in education lies in strategies in terms of budget spending efficiency, the struggle to draw the interest of foreign direct investment and to preserve the most favourably experienced Africans in Maths and Science (Govender and Gruzd, 2011). Consequently the short supply of high-level skills is extensively confining the ability to develop the economy (Simkins *et al,* 2009).

South Africa however is at an alarming state with the worst performance in both Maths and Science as released in an international study coordinated and released by the Human Sciences Research Council (HSRC) on 24 November 1996. The study was conducted by the International Association for the Evaluation of Educational Achievement (IEA) assessment on Trends in International Maths and Science Study (TIMSS). The president of the HSRC, Dr Rolf Stumpf commented at the release of the assessment results "These alarming results show that merely tinkering with the symptoms without addressing the root causes of our poor performance in mathematics and science will be a waste of time and money" (Reddy, 2007) hence the need to explore the root cause of poor performance in Maths and Science.

South Africa ranked 45th out of a total of 45 countries surveyed in TIMSS, 2003, in terms of Grade 8 Maths and Science assessment (Dempster, 2007). The study highlights South Africa's country average at 244 for Science and 264 for Maths compared to the international average of 467 for Maths and 474 for Science at the eighth grade level. The

results unveil a substantial variation in Maths achievement between the highest and lowest performing countries, from an average of 605 for Singapore to 264 for South Africa in the mathematics assessment (Dempster, 2007).

The problem of poor performance in Maths and Science started at the primary level, with approximately 75% of the poorly performing school system experiencing poor arithmetic ability from their learners. Consequently further mathematical education becoming incomprehensible. South Africa is therefore confronted with a massive challenge to address the numeracy failure, unless it will not accomplish the system-wide and prolonged improvement in the Maths and Science education reform, in terms of remedying the poor performance symptoms (Rule & Bernstein, 2009).

There is an increasing need to excel in Maths and Science education, as it is the doorway towards building a developed country but to achieve that requires a scientific and technological advancement that will facilitate growth and development of the economy, this is necessary especially to face the fierce global economic competition (Mji & Makgato, 2006; Dimmock, 2011). Commenting before the release of the assessment results, the executive director of the assessment technology and education evaluation research programme in the HSRC, Dr Anil Kanjee stated that “This is especially relevant for mathematics and science education in South Africa, an area that the nation has recognized is in need of significant improvement if we are to participate and excel in the global economy” (TIMSS SA, 2003).

1.3 Problem Statement

In light of the persistent national crisis in Maths and Science education and the role that Maths and Science plays in citizenship empowerment. It is necessary to understand the intimate relationship between unemployment, inequality, poverty and the role that Maths and Science education plays in dealing with the factors in South Africa. South Africa is amongst the worst in the world in terms of inequality, with a Gini-coefficient in the range of 0.58 – 0.68 and between 18-24 million of the South African population in poverty and about 36.7% in unemployment including those who are not actively looking for employment (McGrath & Akoojee, 2007).

The government plans to eradicate poverty through creating 5 million jobs through the new growth path by 2020 by redressing the inequality through deliberate affirmative action and practices. The education system is a key element of the new growth path. It plays a vital role in the transfer and development of skills and technology. In terms of Maths and Science, the new growth framework seeks to strengthen procedures to guarantee better and more reasonable admission to science and Maths education at secondary level (Patel, 2010).

1.4 Purpose Statement

The subject of Education, especially Maths and Science has been at the helm of many discussions in South Africa and globally, especially with about 90% of our schools failing to meet the minimum performance standards in Maths and Science. In spite of the above, there's currently insufficient data on the root cause of poor performance in Maths and Science although South Africa is facing a national predicament and this poor performance is actually congesting system-wide remedies (Simkins, 2011).

The role of this research is to close the gap in the exploratory literature of Maths and Science by introducing practical data in the root cause and economical consequences of poor performance in Maths and Science in South African. The research exclusively deals with poor performing subjects namely Maths and Science in South Africa, encompassing results from Primary, Secondary and tertiary schools both in the public and private sector.

1.5 Primary goal of the study

This study's fundamental purpose is to determine the root cause of poor performance in the area of Maths and Science in South Africa. The aim of the primary goal is in the exploration of the central phenomenon (Creswell, 2008). Achieving the secondary objectives normally implies the recognition of the primary objective (Struwig & Stead, 2001). The aim of the secondary objectives is to explore the complex set of factors surrounding the central phenomenon (Creswell, 2008). Hence listed below are the formulated secondary objectives.

1.6 Secondary goals of the study

a. To explore the economic consequences produced by the poor performance in respect of Maths and Science in South African schools.

The above represent the preliminary goals of the research but as the research proceeds the objectives may shift as the findings surface (Struwig & Stead, 2001).

1.7 Research Questions

The research is planned to concentrate on the following crucial questions:

Research question 1: What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?

Research question 2: What are the economic impact as a result of poor performance in Maths and Science?

Research question 3: What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

1.8 Layout of chapters

The research report consists of seven chapters as follows:

Chapter 1: Introduction

A comprehensible indication of what the study concerns is highlighted and the goal of the study is discussed to shed light to the topic. The overview of the research problem, purpose statement, primary and secondary goal and the research questions channelling the study. The following issues are addressed: the role that education plays in the economic development of the country, the state of Maths and Science in South Africa, Cleary highlighting the Maths and Science sectors performance.

Chapter 2: Literature review

An argument that supports the study is presented using relevant, current literature review. The statement of the research problem is refined and an argument is built using the literature. The chapter shows and looks at literature on the topic of Maths and Science, the

economical impact associated with poor performance in Maths and Science and the various types of remedies available for a developing economy.

Chapter 3: Research Questions

The purpose of the research is defined through research questions, since the research is under-researched. This chapter builds up to the point that the following chapters will provide practical evidence to explore the dimension.

Chapter 4: Research methodology

This chapter highlights the method of data collection that will be used. It highlights the unit of analysis, the population, the sample size and sampling method, the research instrument, outlining clearly how the data was collected and the process adopted. The limitations to the study and the ethical considerations are outlined.

Chapter 5: Results

The results are presented in this chapter especially focusing on the qualitative approach; the results of the root cause and the economic consequence are presented in a form of figures and tables.

Chapter 6: Discussion of results

The results in chapter 5 are presented with a link to the research question, the research questions are presented as the major headings. An in-depth analysis of the result is conducted, clearly linking to the literature review and confirming that the research objective is met.

Chapter 7: Conclusion

This chapter summarizes the findings into an organized format, ending with recommendations to the stakeholders and future research.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The objective of this literature review in accordance to the research problems is to further describe the problem in detail. The literature review contextualizes research conducted locally and globally. Relevant publications, journals, reports and academic books were reviewed in order to collect data and discussions on the proposed research, mostly to determine if research of the same nature was not conducted in prior years.

The theory reviewed in this section is categorized into three sections: The root cause of poor performance in Maths and Science, and the economic impact of poor performance in Maths and science. The first part provides a general perspective on Maths and Science poor performance looking at the variables underpinning the subsystems in terms of teacher practice, student achievement, curricular content and state of the government (Reddy, Kanjee & Diedericks, 2007).

The second part is an overview of economic impact with particular reference to Maths and Science, looking at the economy of South Africa and the factors that currently affect the country. Lastly an overview of the role of Government in remedying the poor performance in Math and Science by looking at the success determinants of successful countries with an important influences in Maths and Science achievement and the respective predictors. There is a need for specific insight in the factors that determine the success of Maths and Science as this builds on to the solution of the root cause.

2.2. Root cause of Poor performance in Maths and Science

2.2.1 Root Cause analysis

A **root cause analysis** is used when there's a need to understand and prevent unexpected occurrences and as well when there's an indication for immediate response to the problem. Card, Ward & Clarkson (2011) defines root cause analysis as a "General approach to uncovering the systems-level cause and contributing factors behind an incident" they are further supported by Willard, Chutuape, Stine & Ellen (2012) who

described the root cause analysis as a process that can help in determining an association between the underlying structural level factors and the risk, this can alternatively be used for determining solutions to the level factors.

Root Cause can be determined by using Six Sigma "Analyze" technique, using the "5-why" as a technique to uncover the root cause. Pande, Holpp & Pande (2002) defined Six Sigma as a methodology used to manage a business, department, division or systems. The authors break down the definition into three parts, namely:

1. Statistical measure of the performance of a process
2. Goal that attains an almost faultless performance improvement
3. A system to realize outstanding performance

Thawani (2004) added to the definition of Six Sigma by stating that it is a method that steers high performance data for enhancing quality by correcting the failure and their cause. The author lists the components within the Six Sigma methodology as follows (Thawani, 2004):

1. **Define**—Identify, evaluate and select projects for improvement and select teams.
2. **Measure**—Collect data on size of the selected problem, identify key customer requirements, and determine key product and process characteristics.
3. **Analyse**—explore the data, establish and confirm the 'vital few' determinants of the performance.
4. **Improve**—Design and carry out experiments to establish cause and effect relationships and optimize the process.
5. **Control**—Design the controls, make improvements, implement and monitor.

Root cause can be determined by utilizing the third stage "Analyse" in Six Sigma using the "5-whys" technique that "follows an ordered question and answer series that contains a feedback loop to the previous question" (Baraiko, Beardsley & Wright, 2008), this technique asks 5 whys to a question until a root cause that can be easily developed and if solved may stop the recurrence of the problem that was discovered.

2.2.2 Poor performance in Maths and Science

A large number of studies seem to gravitate towards the problem of Maths and Science education in South Africa as illustrated by the poor performance of Matriculants who failed to meet the admission requirements of Maths and Science faculties (Mabila *et al*, 2006). The problem of poor performance in Maths is one of the most paramount fears of teachers and other Maths educators globally.

Allegations point to the fact that poor performance capitulate negative behaviour and even trepidation of Maths by pupils (Wadesango & Dhliwayo, 2012). South Africa had a very low minimum pass rates requirement for Maths and Science at 29% and 30% respectively in 2010 but learners are not motivated to study Maths and Science as they've observed the failure of others (Mji & Makgato, 2006). Maths and Science were mostly disguised as subjects not for the weak and so this becomes a self-fulfilling prophecy that Maths is a subject for those with greater intellectual ability. The author further adds that the education system methodology of measuring grade passes against the provision of educational quality is at the core of the Maths and Science learner fear complicacy.

Mabila *et al.* (2006) argued that there were several factors that contributed to this phenomenon of poor performance, namely lack of regulation, inadequate resources, poor drive in students and teachers, implementation of policies and lack of parental involvement. Govender & Gruzd (2011) added that Maths and Science had the potential of unlocking the continents economic and developmental decline, but education in Africa required remarkable development; the authors cited that education was disregarded and was not in the focal point of Africa's expansion plan, the author further noted the factors responsible for poor performance in Africa such as lack of qualified teachers, proper infrastructure, learning equipment and enrolment into the Maths and Science subjects which bear fruit to the need for development in those respective areas. Bradbury & Miller (2011) differ in their argument in that the unequal schooling system produced various drawbacks that necessitated restoration but agreed on the factors such as lack of qualified teachers as part of the inequality amongst the other factors which they express as a "lack of excess to successive education levels".

It is clear from the evidence that Maths and Science education failure is caused by various factors and that poor performance is characterized by inequities, scarce resource and strategy.

2.2.3 Teaching Practice

South Africa is reported to be the leading technological giant in Africa but in terms of Maths and Science it fell below its economic opponents Indonesia, Chile and Malaysia. The reason for this lag was due to the lack of Maths and Science graduates who can propel progress forward in terms of knowledge sharing in the space of Maths and Science. The central part of this national dilemma is due to the minimal levels of Maths and Science education in classrooms across Africa (Govender & Gruzd, 2011).

In the recent years post-1994, the education programme in South Africa received a radical change from the traditional programme which was used in the Pre-1994 apartheid era which concentrated at most on the historical, philosophical learning's around the subject of education (O'sullivan. Wolhuter & Maarman, 2010).

The Ministry of Education had prescribed that teacher education programmes have to prepare student teachers for the following seven roles (O'sullivan, Wolhuter & Maarman, 2010):

1. **Learning facilitator.** The teacher should facilitate learning in an inspiring way, and in a way which is sensitive to the needs of pupils. The teacher should also have a thorough knowledge of the subject-content and of the principles, strategies and resources relevant to teaching within the South African context;
2. **Interpreter and designer of learning programmes and material:** the teacher should be able to comprehend and to interpret learning programmes, as well as to select the most appropriate textual and visual resources for a particular context;
3. **Leader, administrator and manager**. The teacher should be able to take decisions on classroom level, be able to fulfill administrative duties on classroom level, and to participate in school decision making structures. Their responsibilities

should be discharged in a democratic manner, and in such a way that sensitivity to changing needs and circumstances are shown;

4. **Learner and lifelong researcher:** the teacher should strive towards sustained personal, academic, vocational and professional growth, through reflective study and research in the learning area, as well as in broader professional and educational areas, and in related fields;
5. **Community, civil and pastoral role:** the teacher should practice and promote a critical, committed, and ethical attitude with respect to the development of a culture of respect towards other humans which respect the stipulations of the Constitution, and which practices and advances democratic values in the school and in society. The teacher should further establish supportive relations based on a critical understanding of community development issues, with parents and with other interested people and parties;
6. **Assessor:** the teacher should comprehend how assessment figures in education, and should be able to incorporate it therein;
7. **Learning area/-subject/-phase specialist:** the teacher should be well versed with the knowledge, skills, values, principles and procedures of his specialty area l-subject l-phase.

The Department of Education in South Africa further embarked on an education reform by changing the curriculum to enforce Maths into the curricular, this they did by adding Maths literacy into the equation as an alternative to Maths; which was done in order to increase Maths participation to a 100%. Although these curriculum reform and educational programme changes were an outstanding government initiative, it added a need for more Maths and Science teachers and commitment from government in ensuring that the strategies in place take shape and effect. Govender & Gruzd (2011) indicated that Africa needed at least 3 million more teachers to cope with the growing enrolments.

Simkins *et al* (2009) qualified the statement by illustrating that South Africa was experiencing the same predicament with an escalating burden of more Maths classes and therefore teachers, this was due to the initiative to enforce Maths learning. This was further aggravated by the shortage of properly qualified and skilled Maths and Science teachers. The issue lies in the education departments failing to recruit talented and bright Maths and

Science graduates who understand and could teach Maths and Science, these crucial skills could not be attracted into the system due to the lack of incentives and low pay.

Govender & Gruzd (2011) revealed shocking statistics in terms of educators in South Africa, which stated that up to 60% of the educators, had not been trained in Maths and Science; part of the main reason is that government was failing to translate their commitment to education into budgetary allocations. Education policies are drafted but the commitment lacks such as the scrapping of teacher colleges, inefficiency in training teachers and outdated teacher practices which resulted in untrained teachers who struggled with the topics and hence imparted knowledge with a lack of foundation in content knowledge and imagination. This has created a poor foundation for the future development of Maths and Science graduates (Govender & Gruzd, 2011).

(Mji & Makgato, 2006) said that Maths and Science are practical subjects and the teaching adopted in classes does not continually suggest practice. In the teaching of Maths and Science problems such as poor time management and incomplete syllabuses as a result of no school learning plan, continued to affect the practical method of teaching.

2.2.4 Student achievement

Firstly in order to measure and gain understanding of the variances in student learning, there is a need for suitable and correct Maths and Science assessment tools. South Africa's inability to participate in most Maths and Science assessments shows the countries inability to recognize the state of the problem or even a need to know how they compete in the global context so as to improve the performance of its student (Venkat, Adler, Rolinick, Setati & Vhurumuku, 2009).

According to Taylor (2010) the overall level of achievement amongst South African children is extremely low; this is not shocking as there are two educational systems in South Africa. The first covers 80-85% of the learners who experience the historically disadvantaged system with traits of low proficiency in reading, writing and numeracy, the second system covers the 15-20% of the students from the affluent groups who achieve world class results. The first system is further aggravated by poor school management, due to lack of resources such as textbooks, study materials and proper school facilities.

Teachers who were qualified and experienced tended to flock towards the more urban and developed provinces to teach in schools with proper school management (Taylor & Derekyu, 2009), hence the situation in the first system is further disadvantaged by inadequate experienced teachers who lack the proper resources or support to elevate their skills. The majorities of the graduates who obtained university entrance were produced in the second system and further enjoyed a social mobility and performance advantage.

Taylor (2010) further indicated that the socio economic status was still the core indicator of student achievement, as supported by the results in performance, in the different school systems. The author noted the following results as conducted in a national socio-economic status study, schools which did not perform satisfactorily had not completed their curriculum coverage which in turn affected the learning capability of the students but this could be due to the learning shortfall from prior years which in turn slows the curriculum coverage.

Math and Science teachers were tested in a simple Maths test and the deficient teachers scored 40% or less, those with higher marks produced students who performed better in Maths and Science, these results showed the importance of teacher knowledge and experience to the student achievement. Taylor (2010) noted that the more materials were available, the better the student performed, which concludes the point that schools which is properly managed produces better student achievement.

2.2.5 Curriculum content

Although the change in curriculum by the Department of Education (2008) was an excellent initiative in terms of rendering Maths education non-negotiable, adding Maths Literacy as a Mathematical wing has caused a nationwide debate The question is what is meant by mathematics in the concept of Maths literacy and the use of the word “Literacy” in conjunction with Maths (Vithal & Bishop, 2011). Looking at the factors that contributed to the poor performance in Maths and Science, the question that arose in regards to Maths literacy was whether Maths literacy was going to contribute to the knowledge required in a Maths economy or will this addition exert pressure on the system and subsequently on to the poor performance? Table 1 below illustrates the design of the competencies that the Department of Education aimed for with the Maths, Maths Literacy and Science Curricula. According to Simkins *et al* (2009) the alteration of the curriculum has added up to 60% to

the mathematical instructional problem since Maths or Maths literacy have become compulsory with the new National Senior Certificate changes. The CDE noted that the introduction of Maths literacy has actually resulted in students, who would have qualified to study Maths with a successive pass, enroll for Maths literacy instead. In 2012 the enrolment of Maths stood at 40% compared to the 60% for Maths literacy as quoted by the Spokesperson of the Department of Basic education, Panyaza Lesufi. This means that South Africa is losing out in terms of potential Maths graduates into the Maths and Science system since Maths literacy results do not equate to a university entrance and is not considered a core Maths subject (Simkins et al., 2009).

Table 1: Maths, Maths Literacy and Science: The New (2008) Curricula

Mathematics	Mathematics literacy	Physical Science
This curriculum is designed for those who intend to follow a career path requiring Maths, or those who are interested in the subject. The competencies aimed for include: • Mathematical process skills, such as making conjectures, proving assertions, and modeling situations; Confident calculation, with and without calculators; • Manipulation of algebraic expressions; • Financial calculations; patterns and transformation of functions; • Two- and three-dimensional geometry and trigonometry; • Basic statistics and probability; Differential calculus; sequences and series; • Solution of unseen mathematical problems; • Historical development of Maths in various cultures; and use of technology in calculations, and the development of models.	Maths literacy is driven by the life-related applications of Maths. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations, and solve problems. The competencies aimed for include: • Use of numbers to solve real-life problems; • Modelling of situations using suitable functions and graphic representation; • Description, representation, and analysis of shape in two and three dimensions using geometrical skills; • Critical engagement with the handling of data (statistics and probability), especially the manner in which these are encountered in the media; and use of technology in calculations.	Maths introduces a more extensive range of mathematical techniques, whereas Maths literacy Starts with real-life situations and develops a more limited range of techniques to deal with them. Physical science is divided into six core knowledge areas: • Matter and materials (integrated); • Systems (chemistry); • Change (chemistry); • Mechanics (Physics); • Waves, sound and light (physics) and electricity and magnetism (physics)

Source: Simkins et al (2009. p.36)

2.2.5.1 The language issue

According to the findings by Wildsmith-Cromarty & Gordon (2009) dialect differences cause uncertainty in terms of what the terms mean and adds difficulty in comprehension. Teachers preferred to have a standardized book in the language of instruction for Maths and Science and as well in the home language for ease of reference.

Probyn (2009) stated in his finding that when home language was used in class, it increased the level of class participation. The author argued that the student needed to cross borders in order to understand the information within the curriculum as the wording is written as if the reader is of the mother tongue, he further adds that learning in a second language infringes on the value system of the student. Probyn (2009) argued that the issue is that learners past experiences are entrenched in their cultural and traditional beliefs, norms and values.

2.2.6 State of government

Dimmock (2011) undertook research in schooling policies, the author explored the development and investigated the consequence of the policies from the changing context of the central government in terms of school relationship. The author compared the policies of two contrasting countries, which had the best performing schools in terms of international assessments, Dimmock (2011) noted that the two policies were more different than similar in the context of cultural values, politics and economic situations influences but the results were satisfactory in the global context despite the differences.

In relation to the study by Dimmock (2011) it is possible to establish that governmental intervention besides the context of the country can produce results which are adequate, as long as they adopt policies which incorporate the country's culture, politics, and economical standing.

South Africa's involvement in terms of school relationship is questionable beyond the budgetary relationship where South Africa spent more than any other developing country in Africa, yet 80% of the overall government spending was on personnel (Taylor, 2010). In a system where teachers are underpaid, the 80% is not justifiable. Simply there has been a lack of targeted investments in innovative solutions and a strong political commitment

over a long period of time to change the social compositions of schools which is more important than school spending in educational achievement (Taylor & Derekyu, 2009).

Education increases productivity and the overall labour market, it develops the ability to innovate and aids in the transmission of critical knowledge for the development of the country. The South African government requires this productivity, labour market and innovation in order to further transform the social compositions of schools, hence without the investment in the school relationships, the government will still lack the resources to innovate (Taylor & Derekyu, 2009).

2.3 Economic impact of poor performance in Maths and Science

The first signs of an economical consequence in the poor performance in Maths and Science lie in the Post-Matric career decision making process and the factors that affect that decision. In South Africa a considerable number of black scholars are lacking in the study of registered programmes, courses or degrees in the field of Maths, Science and technology (Maree, 2008). The author further stated that the results obtained in Matric/grade 12 were the major determinants of whether a learner was accepted into tertiary to pursue their studies, especially in areas of Maths and Science where the country lacks skills.

Maistry (2012) emphasized the importance placed by government in the standardized “Matriculants examination” and the implications it has on the students’ progress into their chosen career. Government stance protects the Matric exam as a tool for improving the standard of education in South Africa, the question still remains on whether this is being met or whether the standardized test is acting as a barrier towards the further advancement of students in chosen careers?

Keble (2012) supported the argument in her current study in which she linked the inability to access tertiary education in order to study towards careers of the learners choice and the detrimental effect it has on the economy with a skills shortage. The author observed that most Matriculants had chosen Maths and Science in order to meet the requirement to their career path and to not be limited to a different career stream of which they are not interested. As it is in South Africa, Maths and Science are a prerequisite for entry into the various career opportunities and hence a solid background is essential.

2.3.1 Socio-economic status

Jenorog *et al*. (2012) defines socio-economic status as a "Multidimensional construct that includes not only measures of wealth, but also education plus wealth". The author illustrates how socio-economic status of the parent affects the cognitive ability and school achievement of the child by showing that poor educational outcomes were related to unfavorable environments. O'dea & Mugridge (2012) supported the argument by proving that students of highest socio-economic status with highly educated parents obtained high Maths and literacy results.

The authors also noted that the gender gap was wider for Maths and Literacy subjects on learners coming from families with a low measure of wealth. Nutritional quality, self concept and the student attitude towards school are some of the factors likely to influence the students' performance in relations to Maths and Literacy (O'dea & Mugridge, 2012). The United Nations (2010) report on Human Development Index, re-iterated that high Socio-economic families were better nourished and healthier with more access to resources, information and a high level of involvement by the parents, who were able to contribute to the children's educational learning and also offer encouragement and guidance. This was due to the parents' educational capabilities as compared to low socio-economic learners.

Bradley & Corwyn (2002) provided further evidence that parents with a low educational background were associated with low levels of educational attainment for their children, they said that "Maternal education was a stronger predictor than paternal education" in the educational attainment of the children especially in language due to the warm nature of the motherly figure who invests time teaching the children. Bradley & Corwyn (2002) further added that the poor performance is exacerbated by teachers who were selective in the attention invested in students, investing less for the low socio-economic group coupled with relatively low reinforcement and encouragement for excellent school achievement, which can result in negative relationships being formed between teacher and scholar, which ultimately affects learning and teacher-student relations.

Andrews, Washington, Yigletu & Nwachukwu (2011) conducted a study that proved that the educational performance of the student was highly influenced by poverty.

Below (Figure 1) is a model that looks at the vicious cycle of poverty and the relationship between low quality education, poor job prospects, poverty and socio-economic status.

Figure 1*: Adopted from (The Vicious cycle of poverty: weak education and weak labour market performance by Prof. Servaas van der Berg, Research Chair in the Economics of Social Policy in the Department of Economics, University of Stellenbosch.)*

The model explores the phenomenon that children from poor families were more likely to receive poor quality education, hence when they join the working force even if they have attained their education to a higher level (Matric), they will experience poor labour market opportunities. This results in the experience of poverty and low socio-economic status which means they are unable to move out of the vicious cycle of poverty. This model is an illustration of how poverty perpetuates itself and how quality education is important to break the cycle of poverty.

2.3.2 Structural unemployment

Bartlett (2012) defined structural unemployment as an individual mismatch, shortage of skills and surplus of different types of skilled labour. The main problem stemmed from an insufficiently educated workforce, where demand for new skills exceeded the education and training systems currently in place. The author argued that the youth with a high unemployment rate of 15-24% were not given the right mix of skills to match the skill demand in the economy.

Baker (2012) argued that structural employment was when there was a “supply constraint for certain types of workers” and if the demand for the skill was to rise there would be a shortage of those types of workers in the market. South Africa has the highest structural unemployment which was standing at 40% deepened by the recent global recession; South Africa had lost over one million jobs between the periods of 2009-2010 (Satgar, 2012).

South Africa’s continued expatriation of natural resources besides the declining investment in domestically productive activities is contributing highly on the structural unemployment (Ashman, Fine & Newman, 2011). Further evidence is given in support of the above statement by the United Nations (2010) report which states that “Firms that produce cheap labour intensive goods or exploit natural resources may not want a more educated workforce” this is largely due to the abundant pool of labour that is available for the level of work. This drive by the government not to concentrate on other productive activities further aggravated the structural unemployment issue.

Structural unemployment has a strong relationship and linkage to poverty that increases inequality in attaining higher education. The post-apartheid government educational system was preventing those who were affected by the historical context of apartheid policies in attaining higher levels of education due to the inherent similarities of inaccessibility (Chibba & Luiz, 2011). The author argued that the method towards poverty and inequality promoted inequity within the school system and needed to be upgraded for quality in terms of “input and output of the education production function”.

2.3.3 Low educational levels and low productivity employment

Low educational level and skills shortage has made it difficult for workers to gain entrance into quality and highly productive employment, this is often exacerbated by the fact that low productivity is a constraint for better employment due to the inability to learn or perform the duties required in the new opportunities (Kanyenze & Lapeyre, 2012). The author further affirmed that the higher the education of the worker, the lower the unemployment probability rate and chances of procuring low productivity jobs, hence the high unemployment in youth is directly reflective of their low educational achievement.

In the case of Namibia, first time job seekers had relatively low levels of education accomplishment “40.5 percent of whom had junior secondary school, followed by primary school (32.8 percent) and senior secondary school education (14.9 percent), with 9.7 percent having no education.” This is proof that the learners were not going to be able to attain high productive jobs and were going to remain at the back of the job trapped in low productivity jobs as a result of their level of education (Kanyenze & Lapeyre, 2012).

2.3.4 Low educational accomplishment and Social unrest

Social unrest is an act of anti-governmental demonstration and riots, mostly due to the fact that the masses have lost confidence in their government especially in a state where the government has the inability to tackle the employment predicament (Curci, Khatiwada & Tobin 2012). The key reason for social unrest lies at the unemployment rate or income inequality, closely followed by the decline in disposable income, government that use force to deal with social unrest exacerbates the unrest and protests, the prevalence of mass media coverage also increases social disorder.

Verick (2012) affirms in his research that the slow transition from school to work is a major driver of social unrest and protest in South Africa. He further added that being able to have access to quality education played an influential function in the differing labour market status. An individual with less educational accomplishment is less likely to acquire employment in the formal sector, which links to the slow transition from school to work and the increase of social unrest due to the inequality when that individual can only be absorbed by the informal sector.

2.3.5 Skills and resource shortage

In South Africa the skills shortage problem is riddled by high unemployment and labour market flexibility, which are escalating (Allais, 2012). The negative effect of this skill shortage is to the South African economic future, socioeconomic growth and global participation. There have been education reforms, to redress the skills shortage, in Maths and Science curriculum but South Africa still faces considerable skills shortage (Rasool & Botha, 2011).

The outcome based model adopted by South Africa to redress the low skill problem which was prevalent in the apartheid era was actually marred with similar outcomes of the apartheid government where the low skilled are trained to specialize in one area of specification. This is detrimental as the low skilled are trapped in low productivity jobs with no motivation to perform well, few opportunities available to excel into other areas. The detriment is that they are not shielded from poverty (Allais, 2012).

Allais (2012) built on and refined the argument by giving an example of a market economy which works, where there is a heavy investment in public education and "industry specific and occupational specific vocational skills", this model promotes labour market flexibility and opens doors for further technical training.

The manufacturing sector in South Africa uses mainly low and general skills that are easily substitutable due to the level of skill requirement and the abundant pool of same skilled workers in the market (kleynhans & labuschagne, 2012) but skills shortage for the high skill requirement is still the main barrier in development in South Africa, this is largely due to the failure in vocational and educational training and their inability to meet the demand for skills (Ryan, 2012).

According to the Economist (2012), out of 3 million young people aged 18-24 years, 70% have no formal qualifications at all, 50% are out of school, training or unemployed. Only 17% of the students with Matric will find employment within a year and 65% will still be unemployed in 5 years. These statistics do not fare well in an economy in need of skills. This is compounded by the poor performance in Maths and Science which further condensed the supply of quality skills and the accessibility to the necessary skill (Rasool & Botha, 2011).

2.3.6 Low earnings growth and low tax income

Undereducated workers are more likely to attain slower earnings growth than others in their occupation and an even lesser likelihood of "upward occupational mobility" (Rubb, 2006). Experience for the undereducated had a positive effect on earnings growth but it is not rewarded at a higher rate as compared to the overeducated or just-educated.

"Tax relief for low income earners comes at the expense of the middle and high income earners" with over 13.7 million taxpayers (Mail & Guardian, 2010) generating at most R749

billion in tax revenue supporting 16 million citizens on social grants who require R105 billion per year (Gordhan, 2012). Education which consumes majority of the revenue is amongst the highest consumers of revenue in South Africa, followed by health and social assistance; most of these expenditures were built to supplement the low income earners.

South Africa has a budget deficit of 4.6% of GDP (Gordhan, 2012) and the middle and income earners are experiencing even tighter squeeze due to the country's inability to produce more income tax payers to supplement the tax revenue and support the growing education expenditure and social assistance (Mail & guardian, 2010).

2.3.7 Return on investment in education

Investment in education is the main vehicle in economic development and a source of social mobility; it increases the availability of human capital who contributes into building the economy through their knowledge and skills (Yusuf & Oluwaseun, 2012). The more educated a nation is, the more they improve their literacy and numeracy and their ability to learn complex tasks increases.

In terms of return on education investment it is dependent on the level of schooling and is difficult to measure because it is implicit, continuing and connected to other factors (Xu & Yang, 2011). The authors affirm that there are two types of returns namely private and social investment. The private returns accumulate at most to the individual and the social return accumulates to the society (the individual included). Government gives more in subsidy to private returns than they take away in taxes (Yusuf & Oluwaseun, 2012).

Sub-Saharan African countries have embarked on efforts to achieve universal primary education and bridge the gender gap in schools. Studies have proven that government intervention and social investment yields returns back into the society and abolishing government primary schools fees which was one of the initiatives instituted by African countries has the ability to increase enrollment, especially since there is great importance in investment in early education (Lucas & Mbiti, 2012).

2.4 Government role in improving the poor performance in Maths and Science

Ndlovu (2011 as cited by Gipps, 1993:40) stated that in terms of Maths and Science education for social justice should be structured in a way that the teacher is trained to be

capable of creating learners who are able to analyze situations, conceptualize and justify critical decisions and so forth. Chipaike (2012) further stated that science formed part of the social environment and connected issues of social development; the author noted that science is not merely about manipulation of equipment and laboratory experimentation. It is about education for social development. “Social development is laden not only with concepts but also skills and values such as the development of human potential, moral, cultural and gender sensitivity, participatory democracy, collaboration, unity and peace” (Chipaike, 2012). Ndlovu (2011) commented that without Maths and Science, inequality in terms of opportunities and social isolation are exacerbated as Maths and Science enforces citizenship empowerment.

Hickling-Hudson (2004) stated that in Cuba which has a dedicated programme to develop teachers in Maths and Science education and has outperformed all the other Latin countries, the teachers have at least a 5 year university degree, Master or PhD level, foreign exposure in terms of expertise and also receive consistent training. Dimmock (2011) argued that a school policy which has a designated segregation of talent is more likely to achieve excellence, in Singapore they have a specialist school in science and technology, which is endorsed by the government and allocated the cream of the crop in resources.

China is the second largest economy in the world and is emerging as a world power in education. In the past it was ravaged by a Cultural Revolution engulfed by the traditional rote learning in Maths and Science education (Liu, Liang & Liu, 2012). China has since produced the greatest number of PhD students in the world in natural science and engineering field passing the USA.

The Chinese government embarked on a curriculum reform program in order to develop and grow their economy, their mission and strategy in the science education curriculum was to change from “transfer of knowledge into development of students’ scientific literacy with inquiry-based teaching” their aim was to be in line with the international trends so as to allow competitiveness. The role of the government was to ensure that the teachers were trained well in the new curriculum by establishing new university courses to facilitate learning, create books and teaching materials to complement the new curriculum and professional development programs (Liu, Liang & Liu, 2012). These government

interventions have resulted in a positive progress in the Maths and Science education in china.

Grek (2009) gave the example of Finland and the role of the government intervention in the education curricular which saw success in the country, Finland which has scored 1st in the PISA (Program for international student assessment) for nearly a decade also underwent a curriculum reform, which has since resulted in greater curricular flexibility. The government involvement moved from strict supervision to drafting the national curriculum framework and handing over control to the local government who could decide on the teaching content.

Teachers are highly regarded by their society; their level of education speaks volume to the respect, in order to gain a license as a teacher they must have a minimum of a masters degree and they are also given the right to choose the resources and teaching materials they'll use to teach their students, ensuring that they teach at their best at all times (Grek, 2009).

Burris (2012) indicated that all countries struggling with poor performance in Maths and science need to learn from Finland and invest heavily in their teachers; after all they are the most important part of the educational system. The author demonstrated that the local government needs to be highly selective and stringent when selecting teachers, in Finland a teacher has up to 10% of acquiring a post on application; furthermore we need to thoroughly train the teachers and improve the environment in which they operate.

Coffield (2012) emphasized the importance of considering the socio-economic context of the country seeking educational reform through teachers, such as historical background, culture, value systems and politics. He added that factors such as teachers union play an important role and should be looked at in reform strategies; the change should not be limited to teachers only but also the factors that influence the performance around the teachers.

2.5 Conclusion

The theoretical construct that supports the research was created in this chapter. The chapter concentrated on gathering information that is concerned with the poor performance of Maths and Science and the economical consequences thereafter.

The chapter explored the four classification in an education system namely, teacher practice, curriculum, student and the government. The economical consequence of a poor performance in Maths and Science were broken down into sub-sections concerning and affecting the economy of South Africa.

Evidence was drawn from different journal articles and the findings reflect that Maths and Science and particularly education are a major factor in economical development and growth.

The following Chapter summarizes the objectives of the research, in regards to the theoretical construct from this chapter, as well as lists the research questions that inform the research.

CHAPTER 3: RESEARCH QUESTIONS

3.1 Introduction

Education in South Africa specifically in Maths and Science has an underlying deep failure rate due to reasons linking to teacher practices, curriculum content, government and student performance as discussed in Chapter 2. Evidence proves that each area of the education system has a fundamental problem that ultimately results in the poor performance in the Maths and science discipline which effectively affects the performance of the economy but there is an underlying cause for the overall poor performance. Hence discovering the root cause and preventing the recurrence is vital to solve the economic impact.

In light of the state of Maths and Science education in South Africa, it is most ideal to recognize the deeper underlying factor that contributes to the failure in Maths and Science from the perception of the professionals in the Maths and Science discipline and the non-professionals who have experienced the economic consequence of poor Maths and Science performance.

The following section summarizes the primary and secondary objectives of the research.

3.2 Research Objectives

The primary objective of this research is to conduct an investigation into the root cause of poor performance in Maths and Science education.

In order to accomplish the primary objective, secondary objectives have been prepared for the following purpose:

- Identify the economic impact of the poor performance in Maths and Science education from the professional and non-professionals perspective;
- Determine the success determinants necessary to facilitate the high/improved performance in Maths and Science education in South Africa
- Compose recommendations to add to the knowledge production on Maths and Science education in South Africa, which could be considered by the Department

of education and the Heads of governing bodies for strategic and policy execution purposes.

3.3 Research Questions

The research is planned to concentrate on the following crucial questions:

Research question 1: What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?

This particular research questions aims to understand the fundamental cause of poor performance in Maths and Science education, the purpose of the outcome being to solve the problem and prevent recurrence by meeting the objective of improving Maths and Science performance.

Research question 2: What are the economic impact as a result of poor performance in Maths and Science?

In identifying the economic impact directly linked to the poor performance in Maths and Science education, the consequences are then highlighted and the problem will be measurable in terms of the effect caused by the poor performance and hence bring rise to possible solutions.

Research question 3: What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

The research is threefold in that it discovers the root cause, identifies the economic impact but also seeks to advice what should be done in order to remedy the poor performance

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The methodological process entailed the theoretical constructs of the research topic, the research design, sampling methodologies, data collection methods, data reliability and the importance of ethical considerations when collecting data. The methodological process explained the rationale of the methodology selected and emphasize the benefits there forth. The research methodology was designed and implemented on the basis of the literature review and the outcomes of the inductive research.

4.2 Proposed Research Method

4.2.1 Theoretical construct

The study will use a qualitative grounded theory approach, based on a sample of eight individuals in distinct fields who were satisfied with their overall Maths and Science performance and eight individuals in distinct fields who were not satisfied with their overall Maths and Science performance. In grounded theory the research questions are directed towards generating a theory of the underlying cause of failure in Maths and Science education and the impact to the South African economy (Caswell, 2008). The theory herein will be based on the outcome of the expert interviews and the information that is generated through the findings of the research.

The qualitative method observed phenomena by finding patterns in the form of themes, categories, concepts and typologies that emerge. By conducting the research in an unstructured method, theory and previous research was not greatly dependent on to inform the research process (Struwig & Stead, 2001). The information which came from the expert interviews drove the results of the qualitative method of research, prior theory was merely to inform and link the outcome if necessary.

Due to confidentiality purposes, the names of the respondents will not be disclosed in the study but will be referred to as Person 1(P1) up to Person 16 (P16) and Expert Person 1(EP1) up to Expert Person 3 (EP3) throughout the study.

4.2.2 Research paradigm

This research was constructed by the theory of qualitative research which focuses primarily on the depth or richness of the data and understanding the issue being researched through the perspective of the research participants. The qualitative research has multiple meanings hence it is crucial to describe the differing characteristics of the qualitative research and highlight how it was utilized in the research (Struwig & Stead, 2001):

- *The participants and researchers' perspective.* This uncovered the viewpoint of the participant, through their eyes.
- *Contextualism.* This allowed the researcher to gain insight into the macro and micro contexts of the participants and also to how the context relates with each other.
- *Process.* Investigated the events which were related along a timeline such as how a previous event plays a role in the participants' belief or mannerism.
- *Flexibility and the use of theories.* Approached the research with an open mind and had little reliance on theory in order to be receptive to unforeseen events.

The qualitative research approach was selected for its effectiveness in revealing the participants and researchers' perspective, contextualism, process and flexibility (Struwig & Stead, 2001). This approach is important in that it allows for the unobservable phenomenon to count and hence reveal information on how people feel, see things, reason and understand the world. (Saunders & Lewis, 2012)

The literature focused mainly on "how to do", but the qualitative methodology helped in optimizing the outcome (Morse, Barret, Mayan, Olson & Spiers, 2008). In this study, the importance was on gathering and understanding the experience and conceptualism of the individuals who have studied Maths and Science, due to the exploratory nature of the research (Struwig & Stead, 2001).

4.2.3 Rationale for proposed method

The study was exploratory in nature and the emphasis was on investigating the underlying cause of poor performance in Maths and Science and the impact to the South African economy, the angle of the study was a fairly new research concept.

The HSRC 2004 report stated in their research that fidgeting with the symptoms without tackling the root causes of our poor performance in mathematics and science was a waste of resources and time. This statement proved that there was definitely a need to explore the root cause and address the poor performance hence the rationale for the proposed qualitative methodology.

In order to ensure validity and reliability of data collected with the Qualitative methodology, verification strategies looking at the following components were conducted (Morse *et al, 2008)*:

- *Methodological coherence.* Ensuring correspondence between the research question and the workings of the method.
- *Sampling sufficiency.* Ensuring that a Selection of representative participants with sufficient knowledge of the study can be done.
- *Collecting and analyzing data concurrently.* Ensuring that there is a repetitive interface between what is known and what needs to be known.
- *Thinking theoretically.* Ensuring that new data can be verified within the collected data.
- *Theory development.* Being able to move from a narrow point of view of the data collected to the broader understanding.

The above verification strategies were conducted in conjunction, to ensure reliability and validity of data and therefore qualify the qualitative approach precision.

4.3 Research scope

The scope of the research is explained by the definitions of the significant terms as follows:

4.3.1 Root cause

A **root cause** is defined as a deeper underlying factor, basic or causal factor of a problem, the purposes of defining what a root cause is, is to solve the problem and prevent recurrence (UND school of medicine, 2006). The root cause is discovered through asking questions as follows (UND school of medicine, 2006):

- *What happened?* What happened in South Africa that caused the poor performance in Maths and Science?
- *How did it happen?* What are the events that unfolded that resulted in the poor performance in Maths and Science?
- *Why did it happen?* What are the reasons that there was poor performance in Maths and Science
- *What can be done to prevent it from happening again?* What are the systems that can be put into place to prevent a recurrence?

A root cause is explored through reviewing system based problems not people based problems i.e. failure to follow procedure, insufficient training and so forth. In order to achieve credibility that the root cause was explored in the correct manner, the exploration Includes participation from leadership and by individuals most closely involved in the processes and systems under review, the root cause exploration does not contradict itself or leave obvious questions without answers and includes consideration of any relevant literature (UND School of Medicine, 2006).

4.3.2 Maths, Maths Literacy and Science

For purposes of the research, the South African convention of shortening the word 'Mathematics' to 'Maths' will be used (Govender & Gruzd, 2011). **Maths** is defined by

Simkins et al. (2009) as an extensive range of mathematical techniques. The introduction of the NSC has required a change in curriculum in Grade 10 and Grade11 from 2006 to 2007 onwards respectively; part of the changes involved the study of either Maths or Maths literacy.

Maths literacy is often referred to as Numeracy, Quantitative Literacy, Matheracy, as some part of Ethno mathematics, or related to Mathematics in Society (Vithal & Bishop, 2011). It Starts with real-life situations and develops a more limited range of techniques to deal with them (Simkins et al, 2009).

The term Science also refers to **Physical science** which is divided into six core knowledge areas (Simkins et al, 2009):

a. Matter and materials (integrated);
b. Systems (chemistry); change (chemistry);
c. Mechanics (physics);
d. Waves, sound and light (physics);
e. Electricity and magnetism (physics).

The study concentrated on the education system as a whole from the bottom and top end of the schooling system, namely primary, secondary and tertiary schooling system within South Africa. Although this is a broad study, a concentrated effort at this level would not help the study determine the root cause of poor performance in maths and science hence the entire schooling system is combed out for root cause evidence.

4.3.3 Satisfied and Not Satisfied

For purposes of the research, the terms "**Satisfied**" and "**Not "Satisfied**" were used to categorize the respondent sample into two distinct groups. **Satisfied** in this context meant the respondent was contented with their performance in relation to Maths and Science, obviously relating to the fact that they have passed the subjects up to Grade 12 and felt fulfilled with their overall achievement.

Not satisfied in this context meant that the respondent was not contended in their performance whether passed or failed, hence they were not fulfilled with their overall achievement in relation to Maths and Science.

4.4 Research instrument design and process

In exploring the root cause, the basic steps involved gathering facts by using literature and questionnaires, understanding what happened and hence discovering the root cause. The process involved reviewing the documents related to the poor performance in Maths and Science, interviewing specialists and those affected by the poor performance with an aid of a questionnaire and thereafter observing the typical process of analyzing and creating a model to incorporate all the findings.

The research was conducted using one investigative tool, open-ended questionnaires with past learners of maths and science, split into two categories of those who were satisfied with their overall Maths and Science performance and those who were not satisfied with the overall Maths and Science performance.

The open-ended questionnaires' most important advantage was that it presented a space for pre-determined questions on the topic being explored and allowed for a certain level of deviation and probing (Struwig & Stead, 2001); the research was conducted in 3 phases as follows:

Phase 1: This phase consisted of open-ended questionnaires sent to eight past learners in distinct career streams who were satisfied with their overall Maths and Science performance. The core objective in regard to the open-ended questionnaire was to establish their experience and views on the systems and processes within the education of Maths and Science and to share on the economical consequences of poor performance from their observations and knowledge. The purpose of interviewing these past learners was to help formulate the problem by understanding what worked in the Maths and Science education process and what did not rather than to develop conclusive evidence.

Phase 2: This phase consisted of open-ended questionnaires with eight past learners in distinct career streams who were not satisfied with their overall Maths and Science performance. The core objective of this phase was to explore the outcomes and reasoning behind their dissatisfaction of their performance in Maths and Science.

The respondents were sent open-ended questionnaire (Appendix A) through an e-mail, the questionnaire was approximately 24 questions long and the estimated completion time was 30-45 minutes depending on a variation of disturbances in regards to completing, understanding and conceptualization of questions.

Phase 3: This phase consisted open-ended questionnaires sent to 3 experts in socio-economic matters (See appendix B for the Expert Maths and Science questionnaire), namely education specialists, Maths and Science experts and economists. These experts were selected on the basis that they might provide interesting evidence about the interaction between the poor performance in Maths and Science and the impact of the poor performance (Struwig & Stead, 2001).

4.4.1 The Open-Ended Questionnaires

The questionnaires were designed to collect data in terms of personal opinions and views from the respondents and experts on the underlying cause of poor performance in Maths and Science and the impact to the South African economy. They were used as sources of thoughts, contributor of details and finders of problems.

The first most important aspect when designing the questionnaires was deciding how to construct the questions so that they align to the research question specifications, the second important factor was deciding value how to ask the questions so that they are not too open that they are not substantive in. The questions were constructed to be focused and allow only for relevant and responsible answers. Listed below are the processes of questionnaire design for past learner and the experts.

1. **Past Learners questionnaire**

The questionnaire which was sent to the past learners was designed firstly to gather data on the respondents demographic and background information in order to ascertain their context and socio-economic stance. Secondly, closed ended questions requiring simple yes or no answers and multiple-choice questions were asked to understand specifics of their Maths and science educational background and experiences. Thirdly open-ended questions, worded in a simple and clear manner, were asked to probe into the reasons for their poor performance in Maths and Science and the impact this had on their lives. The overall number of questions was 25.

The procedure for selecting past learners to answer the questionnaire involved reaching a balanced perspective in the responses. Therefore to avoid the responses being skewed negatively or positively, respondents from the different side of the spectrum. Those who were satisfied with their performance and those who were not satisfied with their performances were selected to participate in the research.

2. Expert Questionnaire

The questionnaire designed for the expert was constructed to help collect data on the interaction of poor performance in Maths and Science and the economy. The questions were open-ended in nature and required a little demographic information to ascertain which field the expert emanated from. Firstly the questions were designed specifically to answer the findings of the theoretical constructs in chapter 2. Therefore relevance was made on each question according to the theme of data collected in the theory. The questions were clear and concise but required knowledge in socio-economic matters. The overall questions were 12.

In order to achieve a thoughtful reflection from the respondents towards the questions, the open-ended questionnaires were e-mailed to the respondent so they can have time to think about the answers and offer quality feedback. The other important aspect required to promote quality, was letting the respondent know how important their contribution was to the study.

4.5 Population of reference and unit of analysis

Saunders & Lewis (2009) define population as the complete set of group members, the set is not limited to people but may include organisations as well. It consists of all potential participants in the exploratory research. The population targeted for this study was namely previous learners of Maths and Science. The units of analysis for phase 1 of the research were the learners who were satisfied with their overall Maths and Science performance and the unit of analysis for phase 2 were learners who were not satisfied with their overall Maths and Science performance regardless of what level they did Maths and Science.

4.6 Sampling method and size

Table 2: Research Phase and the Respective Sampling Procedure

Research Phase	Aim of phase	Research method	Data Collection method	Sampling Procedure	Sample size
Phase 1	Professional views in regards to the systems and processes within the education of Maths and Science and to share the economical consequences of poor performance from their observations and knowledge	In-depth questionnaire	Semi-structured open-ended questionnaire	Purposeful sampling	8
Phase 2	Interviews with individuals who were not satisfied with their overall Maths and Science performance	In-depth questionnaire	Semi-structured open-ended questionnaire	Purposeful sampling	8
Phase 3	Experts in socio-economic matters relating to education.	In-depth questionnaire	Structured open-ended questionnaire	Purposeful sampling	*3*

Source: Tullock (2010, p.53)

Phase 1, Phase 2 and phase 3: (Table 1) involves a purposeful sampling procedure as it provides a sample of information-rich participants who show certain characteristics that has a strong relationship to the research. “The sample size was not finalized before the study commenced but changed as the study progressed, the sampling of new units continued until new information becomes redundant” (Struwig & Stead, 2001, p122). The sample size selected is between eight individuals per phase, the accessibility of participants, time and other constraints played a major role in the sampling size decisions. In light of the above the sample size was not conclusive as compared to a quantitative research sample size, and was subject to change bearing in mind the restrictions as listed above.

4.7 Data collection

The research focused firstly on the depth and richness of the data. “The data was used to explore, gain new insights and describe what is happening and also to identify general patterns” (Saunders & Lewis, 2012).

Phase 1 and Phase 2: The data collection methodology involved semi- structured open-ended questionnaires and required a comprehensive list of predetermined questions since the aim was to allow the interviewee to express their views as freely as possible but with direction. The data collection technique encompassed the necessary ethical considerations, like ensuring that the participants have voluntarily agreed to take part in the research and ensure confidentiality where necessary (Saunders & Lewis, 2012; Tullock, 2010).

Phase 3: The data collection methodology involved structured open-ended questionnaires with predetermined questions in relations to the literature findings so as to find support, arguments or additions to the literature review findings.

4.7.1 Primary data

The semi-structured open-ended questionnaires were conducted as follows (Saunders & Lewis, 2012):

1. Questionnaire checklists reviewed and consent forms prepared
2. Contacted the potential participants via e-mail or telephone
3. If consented, arranged e-mail questionnaire to be sent with full details of the completion process, including due dates.
4. Followed up, sent reminders and thanked each individual that responded
5. Review the captured data for full completion and any technical errors
6. Saved the captured data

4.9 Data analysis

According to Struwig & Stead (2001, p.169) Data analysis for qualitative research is about organizing and bringing meaning to large amounts of data. The following process was followed:

- Due care was exercised prior to the organisation of data i.e. ensuring that the captured questionnaire were available and complete.
- The file was typed into a word processing program and imported into qualitative data analysis software.
- The information was then clustered into themes using respondent codes. “Codes are labels that assign units of meaning to the information obtained” Struwig & Stead (2001, as cited in Miles & Huberman, 1994).
- In terms of data interpretation it was coherent and focused on the topic in question and accounted for almost all the data.
- The findings were then evaluated after the data analysis with existing theory and research.

4.10 Pilot studies

According to Saunders & Lewis (2012), the researcher needs to pre-test the questionnaire or interview questions to check for understanding of the participants answering process and also to review whether the recording appliances work.

This was done because it is easier to correct errors at a trial stage than at actual inception. In this case Pilot studies were conducted with two individuals both from phase 1 and phase 2 samples. Issues such as language were noted and rectified for simplicity and then adjusted accordingly.

4.11 Ethical considerations

The ethics of research provide researchers with a code of practice in terms of moral conduct when undertaking research. The following ethical conducts were considered on execution of the research (Struwig & stead, 2001):

- *Informed consent.* Ensuring voluntary participants engagement and freedom of withdrawal at any point of the research.
- *Confidentiality.* Protecting the identity and privacy of the participants and their respective organisations if need be.
- *Deception.* Communicate honestly the nature of the study to avoid deceiving participants into participating.
- *Plagiarism.* Ensuring that work which was not the researchers was properly acknowledged in the correct format.

4.12 Research limitations

In execution of the research, due diligence was followed but certain limitations were noted that may impact the outcome of the results:

- Time limitations have resulted in the research being conducted on a small population, within one segment of the education system, the learner. The other key players in the system such as government, policy makers and educational boards were not interviewed in their capacity. If the study was to be generalized for a larger population, more participants would have to be interviewed.

- The study required an exploration of the root cause, the populations being interviewed were not experts on root cause analysis.

- The budget constraint was also a limitation to the scope of the study and a barrier to geographical sampling. If budget was not a constraint, a bigger sample in more geographical areas will have been collected.

- The nature of the questionnaire which requires time, effort and research to complete, was a limitation in gathering information from some experts who preferred interviews but were also not available for interviews.

4.13 Conclusions

For the purposes of the research the methodology adopted was the qualitative approach used for its investigative technique. The units of analysis were respectively Learners who passed Maths and Science and learners who failed Maths and Science, the learners who studied Maths and Science were selected as the population. A number of 16 past learners of maths and science subjects were selected as well as 3 experts in socio-economic matters. These past learners were selected using a purposive sampling since the participants showed a character that was of interest to the study and the experts selected on the basis that of opportunistic sampling in order to support the findings from the literature.

The research instruments and data collection method consisted of semi-structured open-ended questionnaires which allowed for a certain degree of control in terms of exploring the study by allowing for predetermined questions.

CHAPTER 5: RESULTS

5.1 Introduction

The following results are presented in a narrative, descriptive and thematic approach, representing the thematic content data account methodology for the demographic details and the idiographic account for the background information. The themes are derived from the content which is collected from the open-ended questionnaires which are supported by the theoretical framework context and the 3 research questions which serve as a principle for the thematic categories.

The first phase of the open-ended questionnaires was with those who were satisfied with their performance in Maths and Science and the second phase was with those who were not satisfied with their Maths and Science results. The third phase was with experts and specialists in socio-economics related to the poor performance of Maths and science, from the Maths and Science career stream. Geographical context did not play a role in the questionnaires as they were sent via e-mail and responses were received using the same methodology.

The first and second phase necessitated a lot of background and demographic information in order to determine the socio-economic and current economical situation of the respondents.

The results aim to focus on the following research questions:

Research question 1: What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?

Research question 2: What are the economic impact as a result of poor performance in Maths and Science?

Research question 3: What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

The discussion of the results from the open-ended questionnaire is presented in deep detail in the following section. The identity of the respondents is protected and hence coded to ascertain confidentiality and maintain consistency.

5.2 Results from phase 1 (Satisfied with their Maths and Science results) open-ended questionnaires

5.2.1 Demographic and background information

Table 3 is a summary of the respondents' demographic profile using the content data account methodology, the structure is ordered in terms of gender, age range, current profession, salary, business sector employed or conducting business in, highest level of education. Due to the sensitivity of the salary information, which could also act as a deterrent for completing the questionnaire, this question was made optional therefore only those who were comfortable disclosing the information revealed their salary range.

Table 3: Demographics of the Eight Respondents Satisfied With Their Maths and Science Results

Respondent	Gender	Age range	Current Profession	Salary P.A (Optional)	Business Sector	Highest Level of Education
P1	Male	41-50	Procurement Engineer	R500-600k	Automobile	Masters
P2	Female	26-30	Entrepreneur – Education research	N/A	Education	Masters
P4	Male	31-40	(Entrepreneur) Director – Electrical Engineering	More than R1,2 million	Energy	Degree
P6	Male	41-50	(Entrepreneur) Director – Furnishings	R600-800K	Construction and Materials	Masters
P7	Male	31-40	Senior Manager	N/A	Transportation	Masters
P8	Male	41-50	Entrepreneur – Chartered Accountant	N/A	All sectors	Honours degree
P13	Male	26-30	Maths and Science Tutor	Less than R200k	Education	Degree
P14	Female	22-25	Tax consultant	Less than R200k	Public Sector Entity	Degree

Table 4 is a summary of the background information of the respondents who are satisfied with their Maths and Science results, this information is structured into home language, level of Maths and/or science, Maths role model, dream career, area born in, highest education of parents/guardian. This information offers the socio-economic details and

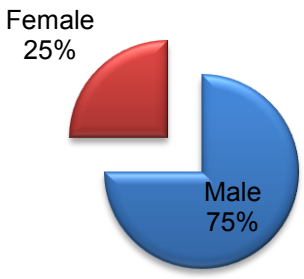
background of each respondent which aid in determining the relationship between socio-economic factors and the performance in Maths and Science.

Table 4: Background Information Of The Eight Respondents Satisfied With The Maths And Science Results.

Respondent	Home language	Level of Maths and/or science	Maths role model	Dream career	Area born in: Rural or Urban	Highest education of parents: Mom/guardian	Highest education of parents: Dad/guardian
P1	IsiZulu	Grade 12	None	Engineer	Urban	Diploma	Diploma
P2	IsiZulu	Grade 12	Teacher	Child Psychologist	Urban	High School	N/A
P4	Xitsonga	Grade 12	None	Engineer	Rural	Less than High school	Less than High School
P6	Other: Bemba	Grade 12	Engineers	Architect	Urban	Diploma	Degree
P7	IsiXhosa	Grade 12	Teacher	Civil engineer	Rural	Honours degree	Degree
P8	Xitsonga	Grade 12	Teacher	Medical Doctor	Rural	Less than high school	Less than high school
P13	Other: Shona	Grade 12	Isaac Newtown	Actuarial scientist	Urban	Less than high school	Incomplete diploma
P14	Xitsonga	Grade 12	Teacher	Social Science	Urban	Never schooled	N/A

5.2.2 Gender

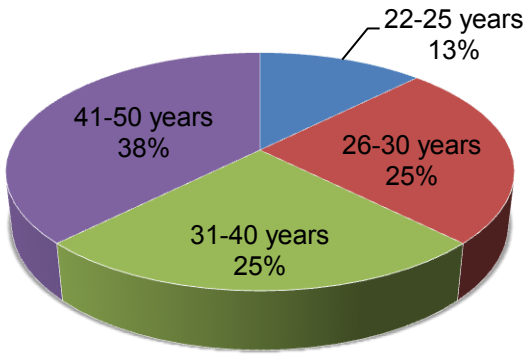
Figure 2: Gender Count of Respondents Satisfied With Maths and Science Results



There was 75% mean percentage of male respondents who were satisfied with their Maths and science results compared to 25% mean percentage female respondents. The males comprised of the majority of the sample as represented in figure 2 above.

5.2.3 Age Range

Figure 3: Age range of respondents satisfied with their Maths and science results



The age range of the majority respondents fell within the age of 41-50, as demonstrated in Figure 3 above, this age-range also constituted the oldest respondents. The minority respondents fell within the age range of 22-25, this age range also constituted the youngest respondents.

5.2.4 Current Profession

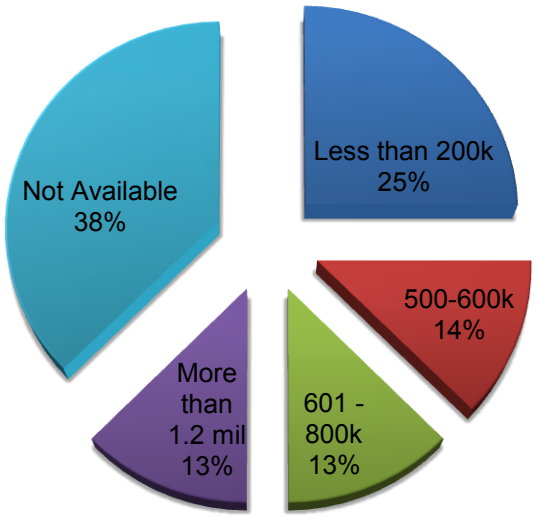
Table 5: Current Profession of respondents satisfied with their Maths and Science results

Current position	Mean percentage
Entrepreneur	50%
Engineer	12.5%
Senior Manager	12.5%
Maths and Science Tutor	12.5%
Tax consultant	12.5%

The majority of the respondents who were satisfied with their Maths and Science results constituted of 50% of Entrepreneurs and 12.5% of each respondents were engineers, tax consultants, senior managers and Maths and science tutors. All positions requiring a dedicated knowledge of Maths and Science.

5.2.5 Salary P.a (Optional)

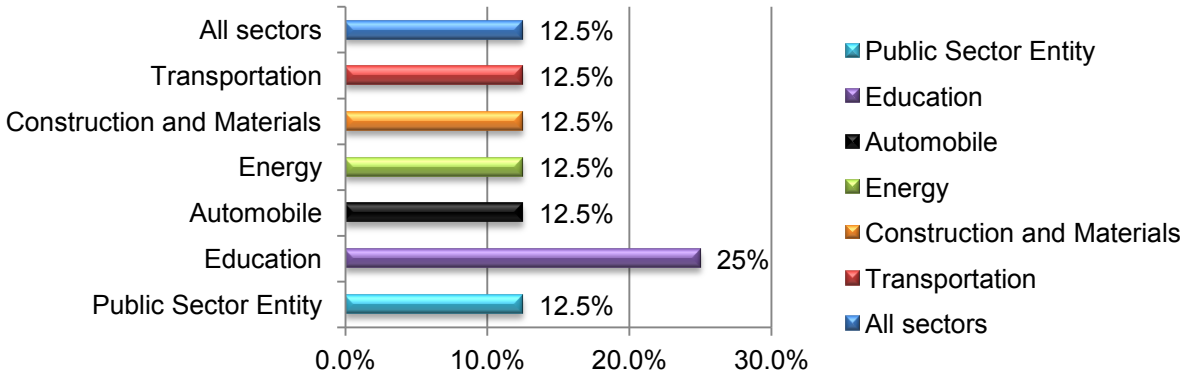
Figure 4: Salary Range of Respondents Satisfied With Their Maths and Science Results



There were 37.5% of the respondents who chose not to divulge the salary range; this information was optional due to the sensitivity of the information. There were 12.5% of the respondents who were satisfied with their Maths and Science results who earned more than 1.2 million per annum which was the highest salary and 25% of the respondents earned less than R200 000 P.a which was the lowest salary.

5.2.6 Business sector

Figure 5: Business Sector of Respondents Satisfied With Their Maths and Science Results



The respondents are scattered equally at 12.5% in different business sectors within the Maths and Science sector. Only 25% are in the education sector as illustrated above in Figure 5, above.

5.2.7 Highest level of education

Table 6: Highest Level of Education of Respondents Satisfied With their Maths and Science Results

Highest level of education	Mean percentage
Masters degree	50%
Degree	37.5%
Honours Degree	12.5%

A tremendous 50% mean percentage of the respondents satisfied with their Maths and Science results had a Masters degree as their highest qualification. In the middle was the 37.5% mean percentage respondents who had a degree and the lowest number of respondents at 12.5% mean percentage had an Honours degree.

5.2.8 Idiographic data account

Rimmel (2008) uses the idiographic account methodology to study the unique characteristic of an individual by recounting the different series of events that made the character unique. In discovering the root cause, a series of the individual events need to be studied in order to determine what caused the poor performance in Maths and Science.

There were eight respondents to the open-ended questionnaires sent to the respondents who were satisfied with their Maths and Science results, the following account recollects the background information of the individuals connected to Maths and Science and their social context.

5.2.8.1 Respondent P1

P1 is a Zulu speaking individual who has done Maths and/or Science up to Grade 12; he grew up in an urban area and was raised by a mother and a father who both had a Diploma as the highest qualification. Growing up he had no Maths and Science role model but dreamt of becoming an Engineer. His perception of Maths and Science is that it is not difficult; his parents were knowledgeable in Maths and Science and his teachers and school as well. P1 states that he understood what was being taught in the Maths and/or

science class even though his school did not offer any additional help in Maths and/or science.

5.2.8.2 Respondent P2

P2 is a Zulu speaking individual who has done Maths and/or Science up to Grade 12, she grew up in an urban area and was raised by a single mother with only high school education as the highest qualification, and there is no mention of a father or guardian. Her Maths role model was her Teacher and her dream career was to become a Child Psychologist. Her idea towards Maths and/or Science is that it's not difficult, her mother knew Maths and/or Science and her teachers and school were knowledgeable in Maths and Science. Her advantage was that she understood what was being taught in Maths and Science and her school also offered additional help in Maths and/or Science.

5.2.8.3 Respondent P4

P4 Speaks Tsonga as a home language, he did his maths and Science up to Grade 12, he grew up in the rural area and was raised by a mother and a father with less than high school as the highest qualification. He had no Maths and Science role model growing up but his dream career was to be an engineer. He feels that Maths and Science are not difficult subjects, this is supplemented by the fact that his parents although uneducated understood maths and Science and his teachers and school as well. He therefore understood what was been taught even though his school did not offer any additional maths and/or science help.

5.2.8.4 Respondent P6

Respondent P6 speaks Bemba, a Zimbabwean language. He completed his Maths and Science education at the Grade 12 level. He grew up in an urban area where he was raised by his mother and father whose highest education qualification was a diploma and a degree respectively. His maths and science role model were engineers and his dream career was to become an architect. He thinks Maths and Science are not difficult subjects, his parents, school and teachers knew and were knowledgeable in Maths and Science. He understood what was being taught in the maths and Science class and could supplement it with the additional help offered by his school in Maths and Science.

5.2.8.5 Respondent P7

Respondent P7 is a Xhosa speaking individual who grew up in the rural area where he was raised by a mother and father with an Honours degree and a degree as the highest education qualification respectively. His teacher was his Maths and Science role model and his dream career was to become a civil engineer. He says Maths and Science are difficult subjects even though his parents, school and teachers knew maths and science and he understood what was being taught in the Maths and Science class in addition to his school offering additional help in Maths and/or Science.

5.2.8.6 Respondent P8

P8 is a Tsonga speaking individual who grew up in the rural area; he was raised by parents with less than high school as their highest education qualification. The rural teachers were his role model and his dream career was to be a medical doctor. He feels that Maths and Science are not difficult subjects even though his parents did not know Maths and Science. His teachers and school however were knowledgeable in Maths and science and he understood what was been taught in class though the school did not offer any additional help in Maths and/or science.

5.2.8.7 Respondent P13

P13 speaks Shona, a Zimbabwean language. He grew up in the urban area and was raised by a mother with a high school education and a father with a diploma as their highest education qualification. His role model in Maths and Science was Isaac Newton and he dreamt of a career as an Actuarial Scientist. He thinks Maths and Science are not difficult and his parents knew maths and Science, his teachers and the school were knowledgeable. He understood what was being taught and supplemented this with the additional help in Maths and Science from his school.

5.2.8.9 Respondent P14

Respondent P14 speaks Tsonga; she grew up in an urban area and was raised by a single mother who has never been schooled, there is no mention of a father or a guardian. Her role model for Maths and Science was her teacher and her dream career was in the social sciences. She feels that Maths and Science are not difficult, her mother did not know Maths and Science but her teachers and school were knowledgeable in Maths and

science. She understood what was being taught in class and her school offered additional help in Maths and/or science.

5.3 Results from phase 2 (Not Satisfied with their Maths and Science results) open-ended questionnaires

5.3.1 Demographic and background information

Table 7 is a summary of the respondents' demographic profile using content data account methodology, the structure is arranged in terms of gender, age range, current profession, salary, business sector employed or conducting business in, highest level of education. The salary information was made optional due to its sensitive nature which could also act as a deterrent for completing the questionnaire; hence only those respondents who were comfortable disclosing their information revealed their salary range.

Table 7: Demographics of the Eight Respondents Not Satisfied With Their Maths and Science Results

Respondent	Gender	Age range	Current Profession	Salary P.A (Optional)	Business Sector	Highest Level of Education
P3	Female	31-40	Entrepreneur	800-900k	ICT-information and communication	Degree
P5	Female	18-21	University Scholar	0	Education	Incomplete Degree
P9	Female	31-40	Administrator	Less than 200k	Healthcare and pharmaceuticals	Incomplete Degree
P10	Female	22-25	Administrator	Less than 200k	Healthcare and Pharmaceuticals	Honours Degree
P11	Female	41-50	Senior Manager	n/a	Healthcare and Pharmaceuticals	Degree
P12	Female	22-25	Marketing Intern	Less than 200k	Media	Diploma
P15	Female	26-30	Procurement Accountant	n/a	Automobile	Degree
P16	Male	50-60	Retrenched/ Retired	n/a	No sector	Diploma

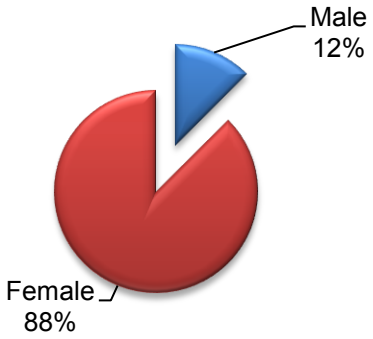
Table 8 is a summary of the background information of the respondents who are not satisfied with their Maths and Science results, this information is structured into home language, level of Maths and/or science, Maths role model, dream career, area born in, highest education of parents/guardian. This information offers the socio-economic details and background of each respondent which aid in determining the relationship between socio-economic factors and the performance in Maths and Science.

Table 8: Background Information Of The Eight Respondents Not Satisfied With The Maths And Science Results.

Respondent	Home language	Level of Maths and/or science	Maths role model	Dream career	Area born in: Rural or Urban	Highest education of parents: Mom/guardian	Highest education of parents: Dad/guardian
P3	IsiZulu	Grade 12	Professor Khambule	Medical Doctor	Urban	Diploma	Less than High School
P5	Xitsonga	Grade 12	None	Law or business	Urban	Degree	Diploma
P9	SeSotho	Grade 10	None	Not sure	Urban	n/a	n/a
P10	English	Grade 12	Stephen Hawking, Leonardo Da Vinci, Neels Bohr, Aristotle	Writer	Urban	Incomplete Diploma	Incomplete Diploma
P11	English	Grade 12	Functional Maths teacher	BCom Law	Rural	Less than High school	Less than High school
P12	Xitsonga	Grade 12	Father	Accountant	Rural	Degree	Diploma
P15	IsiXhosa	Grade 12	None	Law or business	Urban	Degree	Honours Degree
P16	Xitsonga	Grade 12	Teachers	Fighter pilot	Rural	Less than high school	Less than high school

5.3.1 Gender

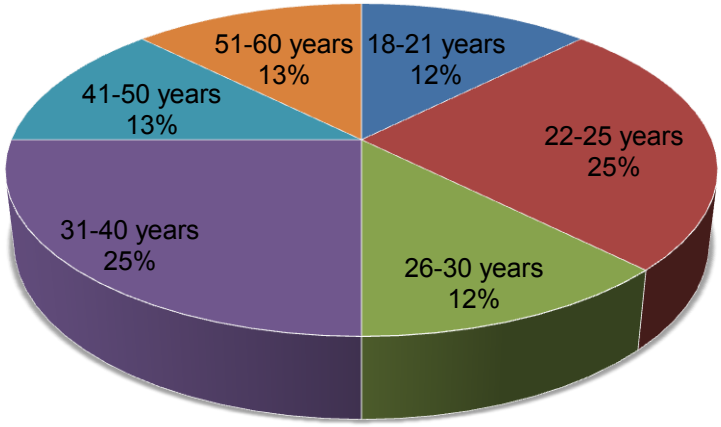
Figure 6: Gender Count of Respondents Not Satisfied With Maths and Science Results



A majority of the female respondents at 87.5% are not satisfied with their Maths and Science results compared to the 12.5% male respondents who make up the sample number of respondents not satisfied with their Maths and Science results.

5.3.2 Age Range

Figure 7: Age Range of Respondents Not Satisfied With Maths and Science Results



An equal number of respondents with the highest mean percentage of 25% fell within the 22-25 and 31-40 age range. The lowest respondents with a mean percentage of 12.5% fell within 18-21 which is the youngest, 26-30, 41-50 and 51-60 age range which is the oldest.

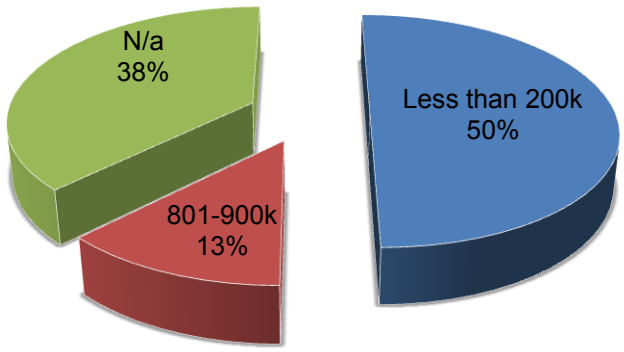
5.3.3 Current profession

Table 9: Current Profession of Respondents Not Satisfied with Maths and Science Results

Current profession	Mean percentage
Administration	25%
University Scholar	12.5%
Entrepreneur	12.5%
Senior Manager	12.5%
Procurement Accountant	12.5%
Retired	12.5%
Marketing Intern	12.5%

5.3.4 Salary P.a (Optional)

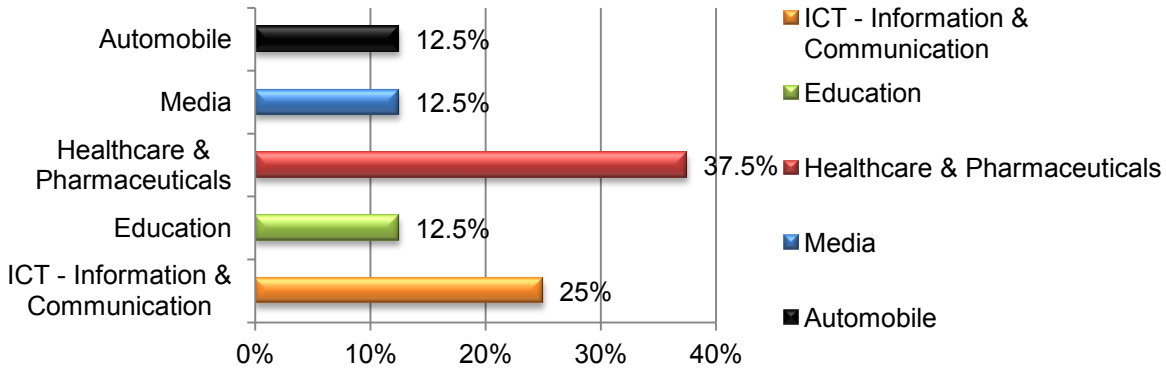
Figure 8: Salary Range of Respondents Satisfied with Maths and Science Results



The majority of the respondents at 50% mean percentage earned less than 200k and 12.5% earned a salary range within 801-900k. The 37.5% of the respondents chose not to divulge their salary scale as this was an optional question.

5.3.5 Business sector

Figure 9: Business Sector of Respondents Not Satisfied with Their Maths and Science Results



A large number of 37.5% of the respondents are employed in the Healthcare and pharmaceuticals business sector followed by 25% in the ICT-information & communication sector. The other respondents are evenly distributed in the automobile, media and education sector.

5.3.6 Highest level of education

Table 10: Highest Level of Education of Respondents Satisfied with Their Maths and Science Results

Highest level of education	Mean percentage
Degree	37.5%
Incomplete Degree	25%
Diploma	25%
Honours Degree	12.5%

The respondents with a 37.5% mean percentage had a degree as their highest level of education followed by the respondents with a 25% mean percentage who had both an incomplete degree and Diploma, lastly 12.5% of the respondents had an Honours degree.

5.3.7 Idiographic data account

There were eight respondents to the open-ended questionnaires sent to the respondents who were not satisfied with their Maths and Science results, the following account recollects the background information of the individuals connected to Maths and Science and their social context.

5.3.7.1 Respondent P3

P3 speaks Zulu, She grew up in an urban area where she was raised by a single mother with a Diploma as her highest qualification, he father though deceased at the time of her birth had less than high school education. Her Maths and Science role model was professor Khambule and her dream career was to become a Medical doctor. She feels that Maths and Science are not difficult subjects though her parents did not know Maths and Science and her school and teachers were not knowledgeable in Maths and Science. Respondent P8 did not understand what was being taught in the Maths and Science class but her school did offer additional Maths and Science help.

5.3.7.2 Respondent P5

P5 speaks Tsonga; she was brought up in an urban area where she was raised by parents with a degree and a diploma as their highest education qualification. She had no Maths and Science role model and her dream career was in law or business. She thinks that Maths and Science are not difficult subjects, her parents knew Maths and science and her school and teachers were knowledgeable but she did not understand what was being taught in class. P5 School also offered Maths and Science additional help.

5.3.7.3 Respondent P9

Respondent P9 speaks English as well; she grew up in urban area. She does not disclose her parents' education; she did not have a Maths and Science role model growing up and is not sure what her dream career was growing up. She feels that Maths and Science are difficult subjects. One of her parent knew Maths and Science and the other didn't, she says her school teacher and school were knowledgeable in Maths and Science and she understood what was been taught in her Maths and science class but her school did not offer any additional help in Maths and Science.

5.3.7.4 Respondent P10

P10 speaks English; she was raised in an urban area by a mother and a father with an incomplete diploma as their highest education qualification. Her role models for Maths and Science were Stephen Hawking, Leonardo Da Vinci, Neels Bohr and Aristotle, P10's dream career was always to be a writer. She feels Maths and Science subjects are difficult and she was fortunate to have both parents who knew Maths and Science. P10 could

comprehend what was being taught in class and she feels her teachers and schools were knowledgeable in Maths and Science and even offered additional help for Maths and Science.

5.3.7.5 Respondent P11

P11 Speaks SeSotho as a Home language, she was raised in a rural area by a mother and a father with less than high school as their highest education qualification. Her Maths and Science role model was her functional Maths and Science teacher and her dream career was in BCom Law. P11 Thinks Maths and science are difficult; her parents did not understand Maths and Science and her school and teachers were not knowledgeable in Maths and Science. At times she understood what was being taught in her Maths and Science class and at times she did not. P11's school did not offer any additional help in Maths and Science.

5.3.7.6 Respondent P12

P12 Speaks Tsonga as a home language, she was raised in the rural area by a mother with a degree and a father with a diploma education. She dreamt of becoming an accountant and counts her father as a Maths and Science role model. She thinks Maths and Science are not difficult and her parents knew Maths and Science, though her school and teachers were not knowledgeable in Maths and Science, she feels she understood what was being taught in class. P12's school also offered additional Maths and Science help.

5.3.7.7 Respondent P15

P15 is a Xhosa speaking individual, she was born in an urban area and raised by a mother with a degree and a father with an Honours degree education. She had no Maths and Science role model and dreamt of having a career either in Law or business. She feels that Maths and Science are difficult subjects, though her parents knew Maths and Science and her teachers and school were knowledgeable in Maths and Science. She understood what was being taught in class and her school offered Maths and Science additional help.

5.3.7.8 Respondent P16

P16 speaks Tsonga as a home language; he was raised in the rural area by parents with less than high school as their highest education qualification. His Maths and Science role model was his teachers and he dreamt of becoming a fighter pilot growing up. P16 feels that Maths and Science are not difficult subjects; his parents did not know Maths and Science and his school and teachers were knowledgeable in Maths and Science. There was no additional help in Maths and Science coming from the school.

5.4 Finding out to what extent language of instruction, teachers' literacy, curriculum content and availability of materials affected the respondents Maths and/or Science performance outcome.

Figure 10: 5 Point Scale Results of Respondents Who Were Satisfied with Their Maths and Science Results

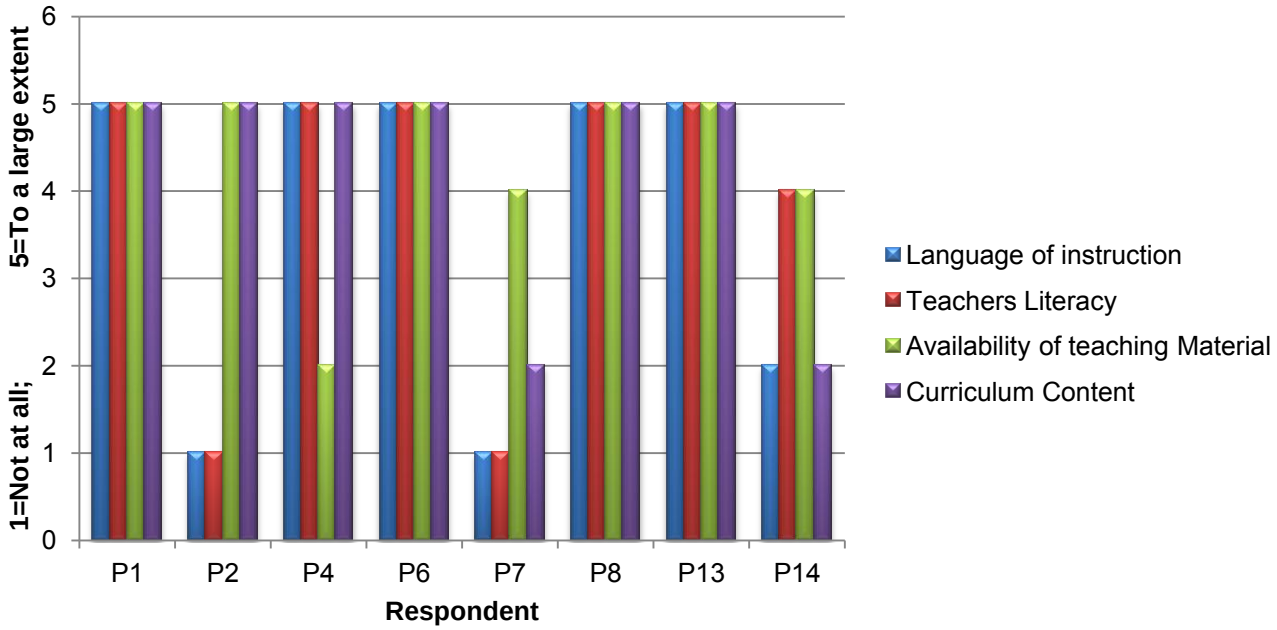


Table 11: 5 Point Scale Results of Respondents Who Were Satisfied with Their Maths and Science Results

5 point scale	Language of instruction	Teachers' Literacy	Availability of Learning Material	Curriculum Content
1= Not at all	12.5%	25%	0%	0%
2= Little	25%	0%	12.5%	25%
3=somewhat	0%	0%	0%	0%
4=considerable	0%	12.5%	25%	0%
5= To a large extent	62.5%	62.5%	62.5%	75%

Figure 11: Respondents Who Were Not Satisfied with Their Maths and Science Results

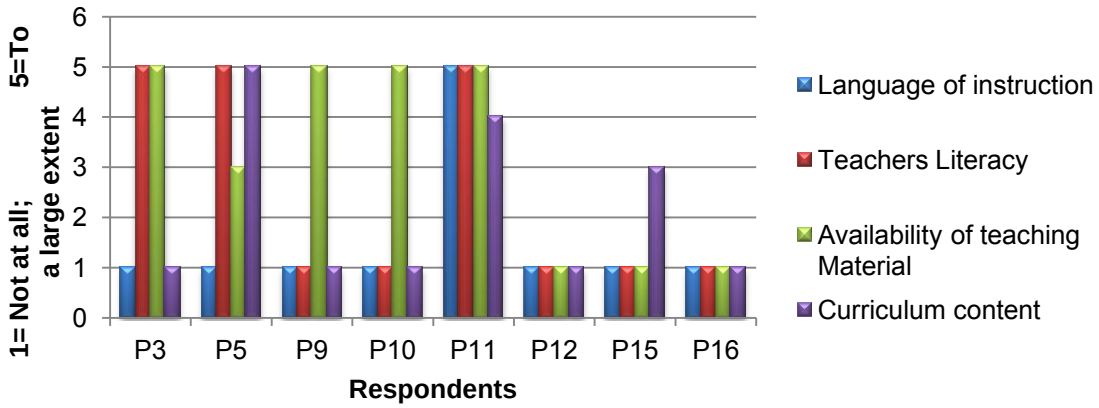


Table 12: 5 Point Scale Results of Respondents Who Were Not Satisfied with Their Maths and Science Results

5 point scale	Language of instruction	Teachers' Literacy	Availability of Learning Material	Curriculum Content
1= Not at all	87.5%	62.5%	37.5%	62.5%
2= Little	0%	0%	0%	0
3=somewhat	0%	0%	12.5%	12.5%
4=considerable	0%	0%	0%	12.5%
5= To a large extent	12.5%	37.5%	50%	12.5%

5.5 Responses from respondents to research question 1

Research question 1: What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?

Research question 1 is addressed by question 17, 18, 19 and 22 on the Maths and Science questionnaire (Appendix A); the questions are phrased as follows:

17: What do you think was the reason for your performance (Pass or fail) in Maths and/or Science?

18: Please elaborate (question 17) as to why this was the reason for the performance (Pass or fail) in maths and/or science?

19: How did your maths and/or science teacher influence your performance (Pass or fail) in maths and/or science?

22: Please describe the availability of Maths and/or Science learning materials (e.g. textbooks, science lab, study guides, chairs and desks, writing books, library…) in your school?

The following Table 13 describes the various responses from the respondents to the 4 questions that try to uncover the root cause of poor performance in Maths and science as depicted by research question 1.

Table 13: Responses From Maths And Science Past Learners (Satisfied With Their Maths And Science Results) To the Questions Addressing Research Question 1

Respondent Number	What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?
P1	"It is because I do understand the logic behind the two subjects…the teacher's simplistic presentation of the subjects…they were available but one needed to read and understand the contents and be in a position to apply the concepts in exams or in real life"
P2	"Maths- quality of teachers, access to resource science- quality of teachers, high quality science facilities that enabled practical learning… As mentioned above, my teachers played a critical role in positively influencing my performance in these subjects. Even though my primary school education was in a township school, the commitment and confidence of the teachers there played a positive role in keeping me interested in the subject despite battling with them initially."
P4	"The teachers just helped me to pass just by teaching and explaining in my own language so that I can understand the concept better… I think I would have done better with access to information and resources and the curriculum could have been easier and more understandable but my pass was due to the fact that I had good teachers."
P6	"Strong family support. Clear role model from parent who were educated and emphasized education daily…the essential ingredients of a good school, Good curriculum, competent faculty Facilities (books , classes, science lab etc) Furthermore an ideal learning environment at home with emotional and financial support is crucial"

Table 14: Responses from Maths and Science Past Learners (Not Satisfied With Their Maths And Science Results) To the Questions Addressing Research Question 1

Respondent Number	What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?
P3	"Teachers themselves did not understand Maths and Science. Attitude that Maths and Science is difficult, it was only later on that I learned that the important thing is to practice… The school should have bought in better teachers. Our teacher instead of encouraging, he used to tell everyone how difficult Maths was, to an extent of telling other students that they must do other subjects, and not Maths."
P5	"I found no need for Mathematics and Science; I didn't think there was any importance for the subject/s. I had no interest in Maths and Science which made it harder for me to pay attention, focus and ask questions to help me comprehend the subject/s. The inability to choose what I wanted to study."
P10	"My teachers played a small role in my performance. When I was able to pay attention, their lessons were certainly valuable. When I was interested I would do extra research. When I wasn't interest and my performance slipped, the opinion of the teachers didn't affect me. When I excelled and they expressed pride, I barely felt it."
P11	"I blame my poor performance on my background, as my parents were illiterate and there was no one to ask questions related to my subject if need be. The teachers were also not fully literate to teach mathematics and science, and the other thing was that only one text book was used, so most of the time was spent on writing notes on the chalkboard which I think was also a total waste of time, considering that there were other subjects also to be taught in the same way. Teachers were often changed and sometimes we would spend three months with no Maths and Science teachers. The medium of instruction also played a negative role to my performance as the medium of instruction was in Afrikaans, and you had to Master the Afrikaans language first at age fourteen or fifteen, before you could understand the subject content and that made me to hate the two subjects. In primary we were taught arithmetic and the transition from Arithmetic to Mathematics was quite a huge change, and it affected my performance. We did not have laboratories for experiments related to Science, so most of our studies were only theoretical and that was converted to practical without physically. You were supposed to cram what was written in the science book, notes given to you by the teacher, without really proving"

5.6 Responses from respondents to research question 2

Research question 2: What are the economic impact as a result of poor performance in Maths and Science?

Research question 2 is answered by questions 20, 21 and 23 on the Maths and Science questionnaire (Appendix A). The questions are as follows:

20: How has your performance (Pass or fail) in maths and/or science influenced your life so far?

21: How would your life have changed if your maths and/or science performance (pass or fail) was different?

23: What role do you think Maths and Science plays in society? What is the importance of Maths and science in the economy?

The following Table 15 and 16 represent the mean percentage of the responses, Table 17 represent the responses from the respondents to the questions that looks for answers to research question 2

Table 15: Economical Impact of Poor Performance in Maths and Science

Economical impact of poor performance in Maths and Science	Mean Percentage
Forced into different career	87.50%
No difference	43.75%
Poor performance at tertiary level	6.25%
underprivileged	6.25%

87.50% of the Respondents felt that a poor performance in Maths and Science had an economic impact into their choice of career due to the reason that they were forced into a different career than would have originally preferred. 43.75% of the respondents did not feel the economical impact of their poor performance in their lives. Poor performance at tertiary was experienced by 6.25% of the respondents and a further 6.25% mentioned underprivileged as an economical impact for poor performance in Maths and Science.

Table 16: Economical Benefit of a Favourable Performance in Maths and Science

Economical benefit of a favourable performance in Maths and Science	Mean percentage
Career opportunities and growth	62 5%
Studied further	25%
Don't know	18.75%
Better life	12.5%

A high number of 62.5% respondents experienced career opportunities and growth and 25% were able to study further after tertiary. 18.75% of the respondents did not know what the economical benefits into their lives would have been had they performed well in Maths and Science and 12.5% feel a better life is an economical benefit of a favourable performance.

Table 17: Responses from Past Learners to Questionnaire Questions Addressing Research Question 2

Respondent Number	Importance of Maths and Science into the economy.
P7	"It plays a major role in the society; it provides requisite skills that are required to stimulate the economy such as engineers, accountants, doctors etc."
P8	"They are both critical subjects"
P9	"I think it's important but not sure to what degree"
P12	I can't say much for science because I never did it in high school. Having good grades for Math is essential, a lot of opportunities are awarded to you when you have Math
P13	It changes the mind set for other opportunities creation being it in business or any other field
P14	"It helps with solving problem and analyzing them from different view and working on getting the best solution for the problem at hand"
P16	"Society relies heavily on technology to solve human problems and improve the quality of life. Technology is a product of science and engineering; both fields relying on mathematical knowledge. A society that does not make advances in math and science will forever be a user of technology and not creators or innovators."

5.7 Responses from the respondents to research question 3

Research question 3: What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

Research question 3 is addressed by question 24 on the Maths and Science questionnaire (Appendix A); the question is phrased as follows:

24: What do you think should change (Teachers, curriculum, government, and student) in order to ensure a high performance in Maths and Science?

The following Table 18 describes the various responses from the respondents to the 2 questions that try to uncover the answer to the question as represented by research question 3.

Table 18: Responses from Past Learners to Questionnaire Questions Addressing Research Question 3

Respondent number	What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?
P1	"To start with, we need to take off all the negative perception (negative energy) that is in our communities (especially disadvantaged communities). Then we need to engage government to put an incentive to attract specialist who know these two subjects to turn to teaching (especially disadvantaged specialist how know the subjects well) so that the children can also relate to them and get encouraged to study these subjects."
P2	"In South Africa specifically, I would say we need to get back to getting the basics of all of the above right- teacher qualification, foundation level curriculum, basic literacy and numeracy, strong and positive partnerships between government, teacher unions and parents and student work ethic. Without all of these things at work simultaneously, the discussions around transforming education are purely anecdotal, if not purely for entertainment value. More broadly, I think more best practice sharing and mentorship could happen between governments and education bodies across the globe- there are so many examples of excellence that we could leverage from countries like Zimbabwe, Germany, Singapore etc. which are not being

	leveraged effectively beyond conferences and discussions that do not go beyond verbal discourse"
P3	"Everyone should be involved. Government – if there are no Maths and science teachers, they should be imported from other countries until we can develop skills locally. Teaches – re-train if necessary, Student – Practice, be passionate and have a positive attitude towards the subject"
P4	"I think first the curriculum should be able to change the way Maths is taught by being practical i.e. electrical circuit shouldn't be based on the batteries it should be based on a house. In terms of teachers they could be trained more through the use of technology, Government can support by building schools, laboratories, libraries and so forth. Students need to be motivated to appreciate the value of science."
P5	"The government should enforce a by-law which allows students to choose whether or not they would like to do Maths/ Maths Literacy (both Maths and Maths Literacy should be non compulsory). The government should 'test' the logical-mathematical intelligence of students to ensure that only capable students (with higher logic/numeracy skills) can choose Maths and Science as a subject. Therefore students who are creative, enjoy writing and reading would not have subjects contrary to their personal skills. Teachers should demonstrate interactivity (not simply teacher to student based learning) when teaching such subjects and focus more on students struggling with Maths."
P11	"I think Government must introduce a new method of learning, and also considering changes of the teachers, the curriculum, and government. The attitude of the student can also change if student are motivated from a younger age to love the two subjects. Parents must also be involved in their children's learning, The Government must learn from other countries like China who are doing well in Maths and science and try and introduce the same curriculum from when a child starts schooling."
P16	"A positive attitude by teachers and learners towards math and science will go a long towards improving performance in those subjects. Government should support initiatives by organizations to establish math and science academies among communities."

5.8 Results from open-ended questionnaires with experts from the socio-economic (Education) environment

5.8.1 Responses from socio-economic experts to research question 1

Research question 1: What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?

Research question 1 is addressed by question 4 on the Maths and Science expert questionnaire (Appendix B); the questions are phrased as follows:

4: What are the underlying problems in the poor performance of Maths and Science education?

The following Table 19 describes the various responses from the expert respondents to the question that try to uncover the root cause of poor performance in Maths and science as depicted by research question 1.

Table 19: Responses from Experts to Questionnaire Questions Addressing Research Question 1

Respondent Number	**What are the underlying problems in the** poor performance **of Maths and Science education?**
EP1	"Poorly educated teachers, Poorly motivated teachers, Poorly run schools – lack of discipline in the school in general, Poorly paid school personnel"
EP2	"Poor educational foundation from the primary level which escalates into the secondary level and teachers who are not properly trained and lack the Maths and Science knowledge and teaching methodology"
EP3	"Teacher literacy in the subject, teacher confidence and knowledge, the ability to translate textbook theory into practical day-to-day examples, poor School administration and the level of remuneration attached to teaching"

5.8.2 Responses from socio-economic experts to research question 2

Research question 2: *What are the economic impact as a result of poor performance in Maths and Science?*

Research question 2 is answered by questions 5, 6, 7, 8, 9, 10 and 11 on the Maths and Science Expert questionnaire (Appendix B). The questions are as follows:

5: How does poor educational outcome link up to the **socio-economic problems** in South Africa?

6: Is education the primary cause of structural **unemployment** in South Africa and if so how can this be resolved?

7: What is the economical impact of youths with low educational levels being trapped in **low productivity** jobs?

8: What is the relationship between low level education and **social unrest**?

9: The demand for people with high-quality skills and qualifications is on the rise, how does the poor performance in Maths and Science affect the **skills/resources shortage** and the growth of the economy?

10: How does low educational achievement lead to **low earnings growth/low tax income** and how does this affect the economy overall?

11: What is the return to **investment** in education, especially Maths and Science?

Table 20 – 26 represent the responses from the respondents to the questions that look to address research question 2. The tables are split into sub-responses for each question in order to ease the responses flow.

Table 20: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	How does poor educational outcome link up to the socio-economic problems in South Africa?
EP1	"Strong link, in general. Poor parents generally have poor education themselves, and thus: 1. cannot help or motivate their children in the early years 2. do not have resources to buy better education for their children 3. often stay/work away from their younger family members/children 4. have reduced ability to judge or influence the school system to deliver quality education for their children 5. inevitably poverty of the parents leads to poverty of the children"
EP2	"Education is a key economic driver. Countries that have a good education system tend to do well economically. We have seen this in South Africa with the poor education, where the country was ranked very low in terms of Maths and Science and resulting in situations where the country's economic is not growing enough to meet the needs and safeguard the wellbeing of the people in the economy. Countries like South Korea and Rwanda have good education system and we have seen the growth in those economies."
EP3	"Poor educational outcomes results in the vicious cycle of poverty. An uneducated society is unable to bridge the poverty gap and hence cannot in turn educate to the best of their ability or afford their immediate families with better opportunities in terms of education and life, this further contributes to the socio-economic problems as the cycle repeats itself through generations"

Table 21: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	**Is education the primary cause of structural** unemployment **in South Africa and if so how can this be resolved?**
EP1	"It is – if one requires skills in one's labour force. Entrepreneurship opportunities in skilled activities are hamstrung if one does not have saleable skills. However, this is compounded if mechanisms such a skills programmes are themselves inadequate – hence if education, industry and state skills development programmes all fail. While the opportunities for training in a work environment (apprenticeship for skills and artisanship) are not available or weak (as they are), the vicious cycle of poverty and lack of skills remains"
EP2	"Most careers that are needed to grow the economy, requires Maths and Science that is engineers, scientist, accountants, doctors etc. In South Africa, we have a situation where there are jobs available, but we also have massive unemployment. Meaning that students are studying for courses that are not relevant or required by the economy as a result they increase the number of unemployment, even though they are educated."
EP3	"Education can be associated to structural unemployment, The economy requires a certain genre of individuals to boost economical activities that will result in growth, there's a great number of skills required and are not being met due to the output of skills in various areas where competition is high but do not match the growth need. Unemployment is rife in areas where entrepreneurial activities are weak and growth slow, because the unemployed never get absorbed. Government needs to stimulate entrepreneurship and support education from the low level with good teachers and administration. "

Table 22: Responses from Experts to Questionnaire Questions Addressing Research 2

Respondent Number	**What is the economical impact of youths with low educational levels being trapped in** low productivity **jobs?**
EP1	"Wastage of opportunity – drainage on social systems (e.g. early pregnancies And inherited lack of opportunity; health risks, de-motivation) and criminality amongst youths who see no future"
EP2	"It is a threat to the stability of the country to have high youth unemployment. The country that has a high number of people who are not economically active and who have nothing to lose usually experience uprising. Once that happens, it is very difficult for investors to consider investing in an unstable country. If there is no foreign direct investment, the economy suffers and the cycle continues."
EP3	"The issue is that they are unable to access exceedingly productive and quality employment, the youth need to participate in the economy in order to alleviate poverty and grow the economy through entrepreneurship, innovation and creation of opportunities. This demoralizes the youth and they are prone to destroy versus building the economy in a quest to stay afloat of their needs and those around them."

Table 23: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	**What is the relationship between low level education and** social unrest**?**
EP1	"1. A generally frustrated population (more than 50% less than 20 yrs of age, with majority unemployment) - will easily take part in social unrest – with an entitlement attitude – as structural failure is seen to be outside the control of the "victim" of poor education and unemployment. 2. I believe that a purpose of education is not only to develop knowledge and skills, but also can produce social cohesion, expectations of mutual respect etc. Without the latter, social unrest is a given."
EP2	"Low levels of education lead to socio-economic instability, people with low level of education tends to depend on the government to look after them. And when the government does not deliver, that is when we see high levels of service level protests that are violent as it is happening."
EP3	"Low level education means low current and future incomes which increases the inequality gap and adds on to the generational poverty cycle. This adds frustration to the population who has to deal with economical demands which far surpasses their income level i.e. rising electricity tariffs, low wages compared to the inflation. Couple this with a government that fails to deliver basic services such as water and sanitation, the population then embarks on a social unrest as a mechanism to be vocal and heard."

Table 24: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	**The demand for people with high-quality skills and qualifications is on the rise, how does the poor performance in Maths and Science affect the** skills/resources shortage **and the growth of the economy?**
EP1	"Competitive manufacturing economy. Our economy then remains factor based (Mining = stealing opportunities from our grandchildren if the income generated is not invested in education and infrastructure) and service based (another name for slavery = forced dependence on someone else's skills and endeavours in order to provide employment.). Democracy fails when Mathematics and Science skills are scarce."
EP2	"South African economy is structured in such that the jobs that are available are specialised and high level of skills, which are required to grow the economy. And at the moment the country does not have enough of those skills, this is due to poor maths and science education."
EP3	"The demand for Maths and Science skills escalates and the supply fails to meet the demand, organisations fail to grow proportionally and economical activities slow and finally stagnate. Manufacturing capabilities need the inflow of Maths and Science, which in turn creates employment, this cannot be done in an economy where there's a shortage of skills."

Table 25: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	**How does low educational achievement lead to** low earnings growth/low tax income **and how does this affect the economy overall?**
EP1	"Many may argue that tax is unnecessary – if all were producing and able to buy services, tax would not be needed…. Nonetheless, indications are that higher level educated people earn much more as a group than those at the low end of education (we shall leave some individuals out of this… presidents included.) If as a general rule, one is paid 1/3 of what one produces… then the equation is simple. Poorly skilled remain poor. Many poor limit the market and development. The impact is great."
EP2	"When one has Maths and science they are accepted in any field of study. Maths and science help a person to be analytic in thinking, which means they can solve most problems. This is the skill that companies require to succeed, so if a person has that subject they tend to do well at the work place and therefore increase their earning potential."
EP3	"Low educational achievement leads to low earnings growth where current and future incomes will remain low, this is largely due to the earning and skill output potential of the individual which does not contribute much to the tax pool and hence the country in general collects from the select few and cannot grow the economy as needed."

Table 26: Responses from Experts to Questionnaire Questions Addressing Research Question 2

Respondent Number	What is the return to investment in education, especially Maths and Science?
EP1	"Let's answer this quantitatively with some estimates: An Engineering degree costs the student about 1/8 of the actual costs as a fee. Fees are about R40000 per year, add living and book s- and we find a degree costs about 8 X 80000 per year X 4.5 years = R2.9 Million. An engineer earns (at least) 500000 per year (just an employed engineer on an early salary level) thus contributes Mil 1.5 per year (once again the simple 1/3 model). With constant Rands, assuming no greater contribution than at this initial level, the engineer contributes Mil 60. The return is thus a factor of 20. If one takes into account that an engineer increases his contribution to ultimately employing in production 16 people earning close to the initial income of the engineer (i.e. technicians and artisans) this factor of 20 increases by at least 16 x … the engineer delivers to the economy several hundred times the national investment in his education (including his own) during his working lifetime. Adding to his "cost" the cost of school education does not change this figure significantly."
EP2	"I don't have the exact numbers, but for careers that require Maths and Science as a prerequisite, the starting salary is usually high than those in fields of humanities, arts, legal, social sciences etc."
EP3	"The return to investment in education far surpasses the initial investment in education when the individual is employed or becomes an employer. A Maths and Science graduate is pulled into the Maths and Science career stream where his earning capabilities currently and in the future are high, he is able to cover his educational investment within three – five years of his career. The graduate is able to educate his siblings and take care of his parents; he drives back wealth back into the economy by his spending capabilities. The social benefit is that he also becomes a role model to the society and community who in turn might emulate his achievements and hence the cycle of return in educational investment trebles."

5.9 Responses from the socio-economic experts to research question 3

Research question 3: What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

Research question 3 is addressed by question 12 on the Maths and Science expert questionnaire (Appendix B); the question is phrased as follows:

12: What needs to be done in South Africa to improve the performance of Maths and Science education?

The following Table 27 describes the various responses from the socio-economic experts to the question that try to uncover the answer as represented by research question 3.

Table 27: Responses from Experts to Questionnaire Questions Addressing Research Question 3

Respondent Number	1. What needs to be done in South Africa to improve the performance of Maths and Science education?
EP1	"Pay mathematics and science teachers' salaries that compete with the engineer. And make a full BSc (not half-baked subjects, but genuine BSc content) a minimal requirement. That will generate a virtuous cycle of at least knowledgeable teachers of science and mathematics. Currently, a bad teacher generates 80 years of damage: 40 years of damage to the learners he teaches, plus 40 years of damage to the career of the last learner he teaches in his 40th year. – And that ignores the cycle of poor educational mastery for the children of that 40th year child learner. In particular, concentrate on strong and correct teaching of mathematics and basic sciences, including discovery learning in primary school years. School principals need to be monitored, trained and given full mentoring support, to ensure that the schools are effectively organized, and provide a safe and orderly environment."
EP2	"The problem in South Africa is that there is too much focus on Matric results, and it is too late to grasp the concepts by then. The focus should be on primary education that is where the government should place best teachers. The foundation should be very good. Because of the shortage of skills, Maths and Science should be compulsory for all students. Copy Zimbabwean model, when the government realised that they don't have enough Maths and science teachers, they imported them from other countries. South African should consider that, until such time that there are enough local teachers. "
EP3	"The South African government needs to have a strong educational agenda, followed by credible strategies that fit the economical context of the country. Up to 80% of the educational budget is spent on salaries for teachers who are still grossly underpaid, 20% goes to administrational needs and both are ill-managed. We need to start comparing our educational results on an annual basis with the developing and developed country to gauge our performance. Teachers need to be highly qualified and equipped before teaching in the classroom, the use of technology to ease learning should be implemented and practical simulation that uses all the senses should be adopted as well in order to aid all students to grasp the learning."

5.10 Conclusion

The sample and results of the research were clearly and concisely presented with the adequate researcher interpretation. Tables and figures were utilized to order the data into an easy and readable format. The data addressed the three research questions whilst incorporating the 3 phases of research, the precise quotations were cited within the framework of the research questions. The following chapter discusses the results in terms of the research questions incorporating the findings from the literature review.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

This chapter concentrates on the discussion of the results in relation to the research questions from the findings as illustrated and interpreted in the previous chapter. The emphasis is placed in relating critical points from the literature with the findings from Chapter 5. Through the analysis of the findings, evidence that the objectives have been achieved will be indicated through the conclusion for each research question.

6.1.1 Demographic and Background Analysis

6.1.1.1 Gender

The respondents who were satisfied with their maths and Science performance had a majority of male respondents of 75% compared to those who were not satisfied with a majority female of 87.5%. There seems to be a relationship between the gender and level of performance.

According to as study by the University of Wisconsin (2008) which quoted that “Self confidence installed by parents and teachers is more important for young girls learning Maths and Science than their initial interest.” The perception around who is stronger in Maths and Science seem to favour boys as they carry that perception. In terms of girls the authors found that engaging teachers and supportive parents had a positive relationship to the way they performed.

Hence from the research data, the majority of the females may have been struggling with confidence and this may have affected their interest and performance in Maths and Science. The males may have the perception that they were stronger and hence performed better.

6.1.1.2 Age Range

The age range of the respondents satisfied with their Maths and Science performance consisted mostly 41-50 year old at 37.5% compared to those who were not satisfied which

consisted mostly 31-40 and 22-25 year old at 25%. The 41-50 age group was highly represented in the study and they were at most satisfied,

6.1.1.3 Current Profession and Business Sector

A majority of the respondents satisfied with their Maths and Science performance was highly represented by entrepreneurs at 50% compared to those not satisfied with the Maths and Science performance which was highly represented by Administrators at 25%. There is a clear distinction in the professions between those satisfied and those who are not. The satisfied respondents are employed in more skilled careers in the Maths and Science career streams, compared to the not satisfied which are spread out in the soft skills careers and business sector.

According to Keble (2012), the poor performance in Maths and Science has a negative effect on the choice of career that the individual can pursue and it also restricts the individual into accessing certain degree courses that could propel their choices. The high representation of the Science, technology, energy and manufacturing sector amongst the satisfied respondents shows what a good performance can achieve in an individual's career prospects.

Andrews & Clark (2012) in their study highlighted that universities were failing to appeal to women in significant numbers especially onto engineering; reasons were that women were still caught in a spiral of low self confidence in relation to Maths and Science and were still subject to the "gender gap socialization". The professions in Maths and Science which were underrepresented by women were still regarded as male-orientated professions.

6.1.1.4 Salary Range

The salary above R500k was highly represented by the satisfied respondents at 37.5% as compared to 12.5% in the not satisfied respondents. There was an equal percentage of 37.5% of missing data as the question was made optional due to its sensitive nature. The research findings prove there is high earning capacity in the high skill career streams compared to the soft skills career stream.

6.1.1.5 Highest level of education

The respondents who were satisfied with their Maths and Science were 50% more likely to study further to masters' degree level as compared to the 37.5% of the not satisfied respondents who seem to have studied up to degree level. This proves that poor performance can hinder the prospects to study further in the future.

6.1.1.6 Idiographic account analysis

The results show that 62.5% of the respondents in both categories were from urban areas and the remainder from the rural areas, this fair representation does not show a relationship between where a person is born and their performance level. Those who were satisfied have scored close to their dream careers as compared to the not satisfied who scored far below than their dream careers. The majority of the satisfied seemed to think that maths was not difficult and they understood what was being taught in class compared to the not satisfied.

6.2 Research question 1

What is the leading, underlying issue which leads to poor performance in terms of Maths and Science?

6.2.1 Discussion of results from the research

The leading underlying issue which leads to poor performance in terms of Maths and Science as discovered in the research data centers on teachers, listed below are the themes which were prominent from the respondents as follows in order of importance:

A. Teachers

The majority of the respondents felt that teachers were their main reason for their failure or success in the subjects. To substantiate this observation; Respondent P2 mentioned that "My teachers played a critical role in positively influencing my performance in these subjects". Respondent P3 further iterates the negative by saying "instead of encouraging,

he used to tell everyone how difficult Maths was, to an extent of telling other students that they must do other subjects, and not Maths."

The respondents felt that teachers were there to demonstrate their understanding of concepts and fundamentals and be able to teach them to the students, helping the student become interested, and place value in the subject by explaining opportunities and using practical scenarios and encouragement. Respondent P13 states that his teacher was "involved and he loved the course and that motivated me to work hard and enjoy the course".

The respondents who did not do well in the subjects felt their teachers lacked the above traits. P5 states in relations to the teachers lacking certain traits that "most of my teachers used the "parrot method" which was not a conducive method to use in helping me enjoy and understand." Respondent P11 feels that her teachers were not knowledgeable in the two subjects as it was not a pre-requisite to be skilled in Maths and Science pre-1994.

B. Self motivation and interest

Self motivation and interest was a close contender to the teacher theme and was used at most in conjunction to the teacher, bearing a relationship of the two themes. The respondents lacked interest in the subject due to the fear and perception of the subject which they felt was due to the teacher as P2 expressed in his comment about the teacher passing down the fear of Maths to the students. Respondent P12 said that his impression towards math in high school was a "Lack of interest, majority of the pupils who were a grade higher than me had a negative attitude towards the subject" which impacted his attitude towards math. Respondent P2 however feels that "the commitment and confidence of the teachers there played a positive role in keeping me interested"

P5 however has a different perspective in terms of how she views Maths and Science and this has resulted in her interest and focus capacity being affected, she stated that "I feel that Maths and Science subjects have been over-glorified; society has branded Mathematics and Science as important, difficult and necessary to secure a better future (in terms of jobs and money). Mathematics and Sciences should not be 'overvalued' in comparison to other subjects. I feel that other subjects contribute to society as equally as Mathematics and Science subjects do." She states that the main reason for failure was her own because "She did not enjoy the subject at all" largely due to the value the school

placed on maths and science which she was against especially since she feels there are other means of obtaining success without the subject.

Self-worth and the search of acceptance seem to have played a role in P10's performance who says that "When I was able to pay attention the lessons were certainly valuable. When I was interested I would do extra research. When I wasn't interest and my performance slipped, the opinion of the teachers didn't affect me. When I excelled and they expressed pride, I barely felt it."

C. Family support

The data proves that the socio-economic stance of the parent affects the performance of the student. The respondents who did well in Maths and Science emphasized the importance of family support from educated, financially capable and involved parents who re-instated the value of education daily. Respondent P5 demonstrated the point when he said that "an ideal learning environment at home with emotional and financial support is crucial" for the successful performance in school.

Respondent P11 feels that the "Lack of assistance in the home environment, Lack of parental guidance" was some of the causes of her failure in Maths and Science, respondent P16 further adds to the argument that "Socio-economic factors contributed to the unsatisfactory result that I obtained. One had to travel long distances to and from school and on an empty stomach most of the time. Studying was done under the light of a paraffin lamp and my parents were not in a position to assist with homework." He re-iterates that studying on an empty stomach was not conducive for learning.

6.2.2 Critical points from the literature review

The above findings in relations to the research question 1 are in unison with the contention raised by Mabila *et al*. (2006), in which they affirm that the factors that contributed to the poor performance were poor drive in students, teachers and lack of parental involvement. Govender & Gruzd (2011) supported the statement further by presenting facts showing that over 60% of the educators in South Africa had not been trained in Maths and Science and therefore lacked the necessary skills and foundation to develop future graduates.

Mji and Makgato (2006) state in support of the findings that learners had a fear of Maths and science after observing the failure of others and this affected their motivation to succeed as the subjects is deemed to be for the more intellectually fit individuals.

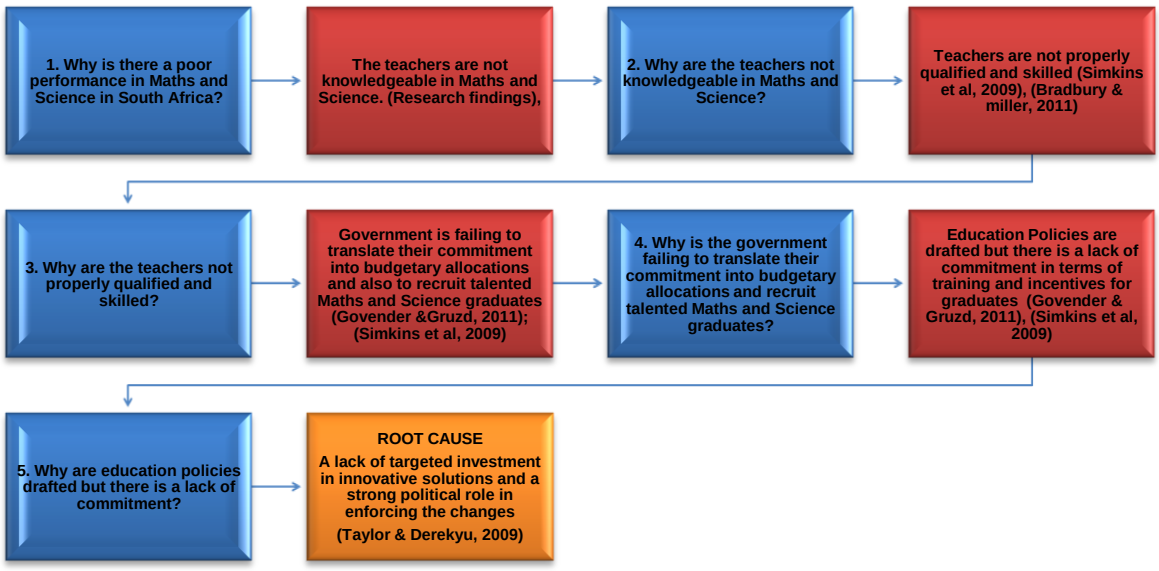
Family support was associated to the socio-economic status of the parents as stated by the United Nations (2010). The report stated that parents with a high socio-economic status were more likely to be involved in their children's education, offer encouragement and guidance due to their exposure from their high educational background as well.

6.2.3 Conclusion to research question 1

The research findings prove that teachers were the main reason associated with either the poor performance or the success of the student; this was closely followed by self motivation and interest of the student as the secondary reason for poor performance and then finally family support. Since the research is concerned with the root cause, which according to Card, Ward & Clarkson (2011) root cause analysis is about finding the systems-level cause and contributing factors behind the poor performance.

Herewith a model using the 5 why's of the Six Sigma "Analyze" methodology (Boraiko, Beardsley & Wright, 2008) to determine the root cause of poor performance in Maths and Science.

Figure 12: 5-Why's Model to Determine Root Cause of Poor Performance in Maths and Science



6.3 Research question 2(a) – Respondents satisfied and not satisfied with their Maths and Science results

What are the economic impact as a result of poor performance in Maths and Science?

6.3.1 Discussion of results from the research

The respondents were asked what the importance of Maths and science into the economy was and respondent P16 responded in response to societal needs in relation to technology in order to advance the economy "*Society relies heavily on technology to solve human problems and improve the quality of life. Technology is a product of science and engineering; both fields relying on mathematical knowledge. A society that does not make advances in math and science will forever be a user of technology and not creators or innovators*", other importance was linked to skills as quoted from respondent P3's response "*Maths and science boost the countries' skills and competitiveness; countries that perform better in Maths and science have better economic prospects*" but P1 equated the importance of Maths and science to all that the humankind does, he quoted "*it is the core to all fields that mankind does on earth, be the health sector, engineering, education, it is because there is specialist that know Maths and Science in these fields and are able to apply them in real life to improve condition of mankind*".

A. Forced into different career

There was an overwhelming 87.5% of the respondents who mentioned being forced into different careers than they would have chosen since they would have had to study a degree unrelated to what they are passionate about as the biggest economical impact of poor performance in Maths and Science. Respondent P5 commented that "*If I had passed Mathematics, I would have a wider selection of degree choices. Basically, by passing Mathematics, I would have had the chance to do any degree instead of having limited choice options*." Respondent P2 further supports the findings "*I do believe that if I had performed better in Science particularly, I might have been in a completely different career (Psychiatry in particular).*" The findings show that performing better in Maths and Science opens door into unlimited choice degree's and ultimately careers. The economy is missing

out on potential addition into the Maths and Science career stream which are currently in need of more skills.

In terms of economical benefit of a favourable performance, a significant number of 62.5%respondents seem to gravitate towards career opportunities and growth as the main benefit followed by the opportunity to study further in life as mentioned by 25% of the respondent.

B. Not much impact

A considerable mean number of 25% of the respondents felt that there was not much economical impact because of their poor performance in Maths and Science. The main reason was that they did well in other arenas and they have been able to succeed in those fields as Maths and Science has been at a very basic level in their careers. Respondent P12 argued that "*Not so much, I work in the media industry and we do not deal a lot with numbers and when we do its basic things that I can comprehend*", respondent P15 cited in support that "*Not much really because later in my high school life I realized I liked accounting and therefore at varsity I pursued the commercial field of study and am ferrying well in my career in that field. This didn't necessarily need mathematics or science in particular.*" The respondents felt that Maths and Science did not play much role economically. The lack of information on the Maths and Science economical benefits is prevalent since 18.75% of the respondents did not know what the economical benefit of a favourable performance in Maths and Science was in relation to their lives and hence there are chances that they cannot comprehend the effect that Maths and Science have had in their lives.

6.3.2 Critical points from the research

The above findings in relations to the research question 2(a) are in agreement to the theoretical construct findings as demonstrated by Keble (2012), in which the author stated that the poor performance in maths and science has a negative effect on the students' future prospects in pursuing their chosen dream careers. Maree (2008) and Keble (2012) indicated that the Matric results underpinned the ability of the learner to advance to tertiary and study towards the career of their choice, special importance was placed on the role of Maths and Science in meeting the skills shortage that drive the economic growth of the economy especially in environments such as built environment, engineering and

accounting and how this subjects can hinder or act as a deterrent towards the student access towards his dream career.

6.3.3 Conclusion to research question 2(a) – Respondents satisfied and not satisfied with their Maths and Science results

Research question 2(a) as answered by the respondents satisfied and not satisfied with their Maths and Science performance. It was clear that the majority of the respondents felt that the negative impact to the economy due to the poor performance in Maths and Science was linked to the choice of their career and also to how this affects their contribution in the future of South Africa being in a profession not initially their choice.

6.4 Research question 2 (b) – Expert

What are the economic impact as a result of poor performance in Maths and Science?

6.4.1 Discussion of results from the research

There were several economical factors that were discussed in order to link up the impact of poor performance in education – particularly Maths and Science to the South African economy. The results are discussed as follows:

1. **Socio-economic problems**

The experts expressed views relating to poverty as a socio-economic problem and how poverty links back to the poor performance in education, Respondent EP3 commented that "Poor educational outcomes results in the vicious cycle of poverty. An uneducated society is unable to bridge the poverty gap and hence cannot in turn educate to the best of the ability…better opportunities in terms of education and life…" The socio-economic problems were looked at from a macro to a micro point of view. The world wide perspective from respondent EP2 expressed a relationship between education and the economical growth of a country in relation to countries which are succeeding due to the educational performance, which in turn increases their ability to "safeguard the wellbeing of the people in the economy. Countries like South Korea have good education systems and we have seen the growth in those economies". Respondent EP1 view is on a micro level where the

parent is the perpetuator of the socio-economic problems due to their level of education, since the parents are themselves poorly educated, they cannot offer support to their children, have a lack of resources to help, are often away due to travels to work, do not understand the importance of their sphere of influence in changing or influencing the education system. The consensus amongst 2 of the 3 respondents is that the cycle of poverty repeats itself intergenerational unless the root which is education is diagnosed and remedied.

2. **Structural unemployment**

All the experts agreed that education may be the primary cause of structural unemployment in South Africa due to factors of skill shortage which is perpetuated by the poor educational outcomes and inadequate skills programmes as expressed by respondent EP1 whose view links up to entrepreneurship "Entrepreneurship opportunities in skilled activities are hamstrung if one does not have saleable skills", he further commented that if all these systems fail, then the cycle of poverty and lack of skills increase. Respondents EP2 and EP1 commented on the level of unemployment and how the opportunities are available but the skills do no match the demand, respondent EP2 emphasized this view "…there are jobs available, but we also have massive unemployment…" and EP3 supported the view "…there's a great number of skills required that are not being met due to the output of skills in various areas where job competition is high (Low productivity employment) but doesn't match the growth need." The reasons and recommendations are around learners enrolling for the wrong courses due to the performance level thereby increasing unemployment. Respondent EP3 felt that the government should "stimulate entrepreneurship to create employment and support education from the low level with good teachers and administration."

3. **Low productivity jobs**

The experts all agreed that there is an economical impact to the youth who have low education levels being trapped in low productivity jobs. Factors such as wasted opportunity, threat to the stability of the country and the psychological effect of low productivity employment were cited by the respondents. On a macro level EP2 commented that investments are hard to come by in an unstable country "…It is very difficult for investors to consider investing in an unstable country. If there is no foreign direct investment, the economy suffers and the cycle continues". Respondent EP1

demonstrated the micro effect of low productivity jobs on the social systems "… (e.g. early pregnancies, and inherited lack of opportunity; health risks, de-motivation) and criminality amongst youths who see no future". Respondent EP3 expressed the importance of the youth being in highly productive employment "…the youth need to participate in the economy in order to alleviate poverty and grow the economy through entrepreneurship, innovation and creation of opportunities."

4. **Social unrest, skills/resource shortage and low earnings growth/low tax income**

In terms of Social unrest consensus amongst the respondents was on the helplessness of the society plagued by poor education and unemployment and their dependability on the state to supplement the income gap with free services. Respondent EP1 gave an example of what education means in the eyes of social unrest "…to develop knowledge and skills, but can also produce social cohesion, expectation of mutual respect etc. Without the latter, social unrest is a given."Respondent EP2 and EP3 were in agreement that the social unrest is propagated by "…a government that fails to deliver basic services such as water and sanitation, the population then embarks on a social unrest as a mechanism to be vocal and heard" as demonstrated by respondent EP3.

There were 2 out of the 3 respondents who referred to the manufacturing industry as being affected by the skills shortage. Respondent EP1 noted that the South African economy is still to factor and service based, supplemented by the predominant corruption in the mineral resources activities where the income produced is not invested back for education and infrastructure benefits "…democracy fails when maths and science skills are scarce".

Low earnings growth is driven by the poor educational achievement according to the experts, EP1 and EP3 link up high education with high earning potential and low education with low earning potential as demonstrated by respondent EP3 "Low educational achievement leads to low earnings growth where current and future incomes remain low…due to the earning and skill output potential of the individual which does not contribute much to the tax pool". In response to the question of how this low earning growth affect the economy EP1 responded by saying "…one is paid 1/3 of what one produces…poorly skilled remain poor. Many poor limit the market and development. The impact is great".

5. **Return on investment in education**

Respondent EP1 illustrated the return using a quantitative method where he demonstrated the economical benefit of an educated engineer whose total educational expenditure is R2.9 million and his earning capabilities in a year are R500 000 and his contribution to the economy will be 150% or R1.5 million (1/3 model) "…the engineer delivers to the economy several hundred times the national investment in his education (including his own) during his working lifetime…" Respondent EP3 illustrates the return of investment from a micro point of view "…A maths and Science graduate is pulled into the Maths and Science career stream where his earning capabilities currently and in the future are high, he is able to cover his educational investment within three-five years of his career…" respondent EP3 further illustrated how the graduate propels wealth back into the economy through his expenditures.

6.4.2 Critical points from the research

The findings from the expert interviews are in line with the findings as expressed by the authors, namely O'dea & Mugridge (2012) who made a link between the learners poor educational performance to the parental low educational level as a result of their low socio-economic status. Andrews *et al* (2011) shows the relationship between educational performance of an individual with the level of poverty and Bartlett (2012) in his study demonstrated the effect of structural employment in that it is the insufficiently educated workforce that have packed the economy where the demand of the skill exceeds the educational outcome.

Further linkages between the study and the theory may be found from the authors Kanyenze & Lapeyre (2012) who emphasize that low levels of education accomplishment means the youth get absorbed in low productivity employment which acts as a constraint towards career growth and exacerbates the poverty levels.

Curci *et al* (2012) addresses the issue of social unrest by discussing the factors causing the social disorder namely, unemployment as a key factor, deterioration of disposable income which is further perpetuated by a growing population which has low confidence in their government to provide services and curb the rate of unemployment.

Kleynhans & labuschagne (2012) commented in alignment with the experts on the manufacturing industry and its need for low and general skills, which are in abandonment and the shortage of high skills which are a barrier to the growth of the economy.

In conclusion, the authors Yusuf & Oluwaseun (2012) ended by commenting on the return of investment in education, which they believe is a source of social mobility and is dependent on the level of schooling invested in.

6.4.3 Conclusion to research question 2(b) – Expert

The theory of the research is supported mostly by the findings and ties all the economical impact factors to the level of educational attainment especially to the crucial subjects of Maths and Science.

6.5 Research question 3 - Respondents satisfied and not satisfied with their Maths and Science results

What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

6.5.1 Discussion of results from the research

The subsystems of education were reviewed in answering what role should the namely teachers, curriculum, student and government. The findings from the research are as follows:

1. **Teachers**

Respondent P1 emphasized on the need to attract specialist with incentives to teach the subjects of Maths and Science. Respondent P3 emphasized that government should import skills from other countries and re-train the local teachers. The use of technology as a tool for training teachers was mentioned by respondent P4. Respondent P5 highlighted the need for teachers to "…demonstrate interactivity (not simply teacher to student based learning) when teaching such subjects…" These initiatives need the commitment of government and action combined amongst many others.

2. Learner

The respondents seem to gravitate towards the student being aided in motivation from an early age to love Maths and Science, to practice and change their attitude towards the subjects in order to achieve a high performance in the subjects. Respondent P10 added in terms of teacher-learner behaviour and conduct that policies need to be effected to protect the teachers from the learners in differing contexts "*The policies concerning discipline are also lacking, because even when the teachers are capable, the students are not compelled to respect them and the learning environment and the rights and needs of other students*." Emphasis was made in terms of parental support which needs to be established by the parents.

3. Curriculum

Respondent P10 said the following in response to the curriculum "The curriculum is under-stimulating, the students are being taught to underperform. A lot more could be put into the courses to better equip students…there is far too much violence in schools. There is not enough social and spiritual engagement. Life orientation is well intentioned but it is not contributing to the social cohesion and understanding of students." Respondent P9 and P11 expressed that learners fear the subjects therefore the government need to introduce a new methodology of learning by making the subjects' learner friendly and fun.

4. Government

Respondent P16 remarked that the government can play a role in increasing the performance by supporting "…*initiatives by organisations to establish Maths and Science academies among communities*." The respondents felt that the government should learn from other countries like China and mimic the same education reform methodologies from the primary level. Respondent P2 shared his opinion in terms of learning from other countries "…I think more best practice sharing and mentorship could happen between governments and education bodies across the globe- there are so many examples of excellence that we could leverage from countries like Zimbabwe, Germany, Singapore etc. which are not being leveraged effectively beyond conferences and discussions that do not go beyond verbal discourse." The respondent felt that commitment and action was vital and necessary to push the high performance agenda forward.

6.5.2 Critical points from the research

The findings from the research support and add to the theoretical construct from chapter 2, the author Liu *et al* (2012) stated China as an example of a successful education reform story, which was largely due to the governmental commitment, action and focused strategy. These findings are in relation to the findings from the research. Grek (2009) added to education reform example of Finland who also had a committed plan to overhaul the old system and adopt a new system backed up by commitment and focus.

6.5.3 Conclusion to research question 3 - Respondents satisfied and not satisfied with their Maths and Science results

The research findings from the respondents who were satisfied and not satisfied with the Maths and Science seem to gravitate towards government as a source of power and parity to move the education reform towards a higher performance strategy. The changes mentioned in terms of Curriculum, teacher, learner need to happen with the sphere of influence of the government through solid committed education reform strategies.

6.6 Research question 3 – Experts

What role should the South African government play to remedy the root cause of the poor performance in Maths and Science?

6.6.1 Discussion of results from the research

The expert respondents gravitated towards the notion of improving teachers as a key and primary initiative by government. Respondent EP2 discussed the importance of primary level education in terms of best teacher practice, as this is the foundation. In case where there are no skills as emphasized by EP2, South Africa should copy the Zimbabwean model and import teachers whilst they train their own.

Issues of incentive were listed amongst the factors to be considered by government, respondent EP1 supports his argument “Pay Mathematics and Science teachers’ salaries that compete with the engineer and make a full BSc …a minimal requirement…” he emphasized the effects of a poor teacher on the learning disruption that he brings to the

table “Currently a bad teacher generates 80 years of damage: 40 years of damage to the learners he teaches, plus 40 years of damage to the career of the last learner he teaches in his 40th year.-and that ignores the cycle of poor educational mastery for the children of the 40th year child learner”

Respondent EP3 concentrated on the impact of poor administration and the need for comparison with other countries in order to determine our stance in terms of performance in Maths and Science. The respondent also added on the importance of technology as a methodology to teach student “…the use of technology to ease learning should be implemented and practical simulation that uses all the senses should be adopted as well…”

6.6.2 Critical points from the research

The findings tie in well with the theory from chapter 2, Hickling – Hudson (2004) mentioned the strategy adopted by Cuba where there is a teacher specific strategy to educate the teachers by giving them foreign exposure, adopting a high educational level attainment in order to be considered a teacher and sufficient, consistent training. Grek (2009) gives the example of Finland which has a minimum requirement of a Masters degree for teaching which means the teachers are experts in their field.

6.6.3 Conclusion to research question 3 – Experts

The evidence from the research was sufficiently matched to the theory in chapter 2, surprising information was unfolded by EP1 in his example of the effects of a bad teacher to a learner, this finding is both interesting and educational in that it highlights the long term effect of a bad teacher and the impact to the economy in the long run.

6.7 Conclusion

The following Table 28 as adopted from Tullock (2010) encapsulates all the knowledge and key findings from the research in relation the theoretical constructs as discussed in chapter 2.

Table 28: Research Evaluation

Research question	Respondents observation	Expert observation
Research question 1: ***What is the leading, underlying issue which leads to the poor performance in terms of Maths and Science?***	The research revealed the importance of teachers to the performance and overall perception of the student to the Maths and Science subjects.	The information specified by the experts was in line with the theoretical constructs of the research and concentrated on the role of the teacher in the performance of the student. The six sigma further revealed interesting data on the actual root cause of poor performance in Maths and Science.
Research question 2: What are the economic impact as a result of poor performance in Maths and Science?	The research added an interesting phenomenon to the theory that showed that the learners' knowledge may also be limited not only on the subject of Maths and science but also on the foundational benefits to the economy of such subjects.	The research evidence tied in well to the theory in chapter 2 and a theme of low educational level being a foundational cause of the economical impacts was uncovered.
Research question 3: ***What role should the South African government play to remedy?***	The theory seemed to gravitate towards the teacher specific strategy and the social implications of an involved government with wealth in Maths and Science, the research findings gravitated more towards the teachers and the role of government in learning from other countries	The research findings were aligned to the theory and added a very interesting perspective in terms of the effect the teacher has on the student using quantitative evidence of generational conveyance of bad teaching.

Source: Tullock (2010), Pg 96.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Introduction

This chapter brings to light the core findings from the research, arranging the findings into a properly organized structure. The managerial implications of the research are cautiously acknowledged and the recommendation for future research is made in this chapter. All of this encompassing the core objective which involves recommendation to the South African Department of education, heads of governing body of school and the teacher's association and unions with information that will assist in the formulation of strategies and the execution of policies. A model incorporating all the learning's is demonstrated in this chapter.

7.2 Research review

The main aim of the research was to explore the root cause of poor performance in Maths and Science and the implications to the South African economy. In order to determine the root cause of the poor performance open-ended questionnaire interviews were conducted with the experts and the past learners involved in the performance statistics of the country. The information was further broken down using the Six Sigma "5-why technique" in order to determine the core underlying systematic problem that needs to be addressed in order to rectify the current performance issue. Although other factors were noted, the main concern was discovering the root cause.

The information gathered from the experts was more towards the economical impact of the poor performance in Maths and science as this information forms the theoretical construct to which the research is supported. This section answers the so-what of the poor performance reasons in south Africa as it highlights the consequences to the economy due to the poor performance.

The information gathered was broken down into themes of those satisfied and not satisfied with their Maths and Science performance in order to measure the negative and positive side of the performance to avoid assumptions. A deep analysis of the data was then conducted.

7.3 Managerial implications of the findings

Although the information is limited to the small population selected for the research, the findings of the research are important in that they uncover the root cause of poor performance in Maths and Science in the South African context. The managerial implications of the findings are:

7.3.1 Teachers

Teachers were cited as one of the main contributors of poor performance in Maths and Science in South Africa, although this seems appropriate as teachers are the most important part of the educational system. The teachers are a human based system and require the strength of systems in their environment to aid them create a favourable learning environment.

This implies that the Department of education, the heads of the governing body of schools and teacher union and association need to have a focused agenda around the teacher strategy towards a high performance in Maths and Science agenda, in terms of selection criteria, license requirements, training needs, local government support, incentives and general support and freedom to perform their duties. This will however require a great muscle of commitment from the stakeholders in order to gain from the process. Great importance must be placed on the different contextual environment that the teachers are from and the teacher strategy adjusted and adopted to fit the context.

7.3.2 Learner

The learner is the greatest tool of measurement in terms of what happens in the classroom, the results reported from the learner confirm the performance of the education system. Inequality is still the greatest hurdle as it acts as a factor in terms of student overall performance, the complications of poverty that affects the learners chances of advancing in school and the teachers perception to poverty stricken learners further implicates the internal administrative weaknesses in the education system.

The implication of this is that learner needs support, a solid support network that facilitates the learners into the world of Maths and Science, demystifies the myths around Maths and

Science as difficult subjects and brings the subjects to life into the real practical context. The mere fact that students have to deal with stresses of poverty and further be subjected to the fear of Maths and Science aggravates their learning fears, hence Maths and Science needs to be presented to the student as a mechanism to solve all their problems and relate it to the natural environment via a facilitative week learning programme in a Maths and Science Academy around the two subjects for every student in South Africa before Grade 10. This should be a governmental initiative to prepare the learner for the education reform towards a high performance in Maths and Science.

7.3.3 Parents

The role that parents play in the performance of the learner is very important and mostly under-appreciated. The parent is a direct role model to the learner in the context of the home, where the learner spends the majority of his time, this support system is crucial for the development of the child. Parents have the ability to inspire, teach and guide their children by sharing their insight and knowledge on life and also provide support where they are unable to themselves. In the different socio-economic backgrounds different parents show different level of commitment the danger is in an environment where the parent fails to acknowledge the need for their involvement due to their inability to realize that involvement is important regardless of their sphere of education and influence.

This implies that the department of education together with the governing bodies of schools need to develop a compulsory feedback and parental involvement tasks between the learner and the student into the curriculum, again this could happen in the context of a Maths and Science academy where the parents and student spend time learning about the realities of Maths and Science, conduct experiments together and compete for prizes in order to stimulate dialogue and get the parent involved in their children's studies.

7.3.4 Government

The supreme solution that may cure the Maths and Science dilemma in South Africa is an involved, strategic and committed government that is realistic about the problems around the performance. There needs to be a "Maths and Science centralized Strategy" which is rolled out with a full commitment and resources to back it up.

This implies that the education reform need to be as serious as the commitment to pay social grants to the 16.1 million citizens every month without fail, systems needs to be placed and personnel assigned with key performance indicators. Concentrating efforts on the education reform especially in Maths and Science will equip the country economically for most of the development that will take the economy forward into competitiveness.

The mere fact that South Africa lacks skills in the Maths and Science field speaks to the fact that although there are graduates ultimately coming out of the school system, the creators of productive employment being the Maths and Science graduates are being absorbed into the working market which entices them with high incentives, thereby capturing them in the world of work loop. Where does entrepreneurship fall into the picture in a country where each skill is needed in the existing businesses?

Educating the masses in understanding Maths and Science may reduce the poor performance in Maths and Science and hence may increase the quality of graduates coming out of the tertiary institution who may positively affect the economical growth. Government may see the reduction of social unrest, structural unemployment, high return in investment and high productive employment. It all starts with Maths and Science.

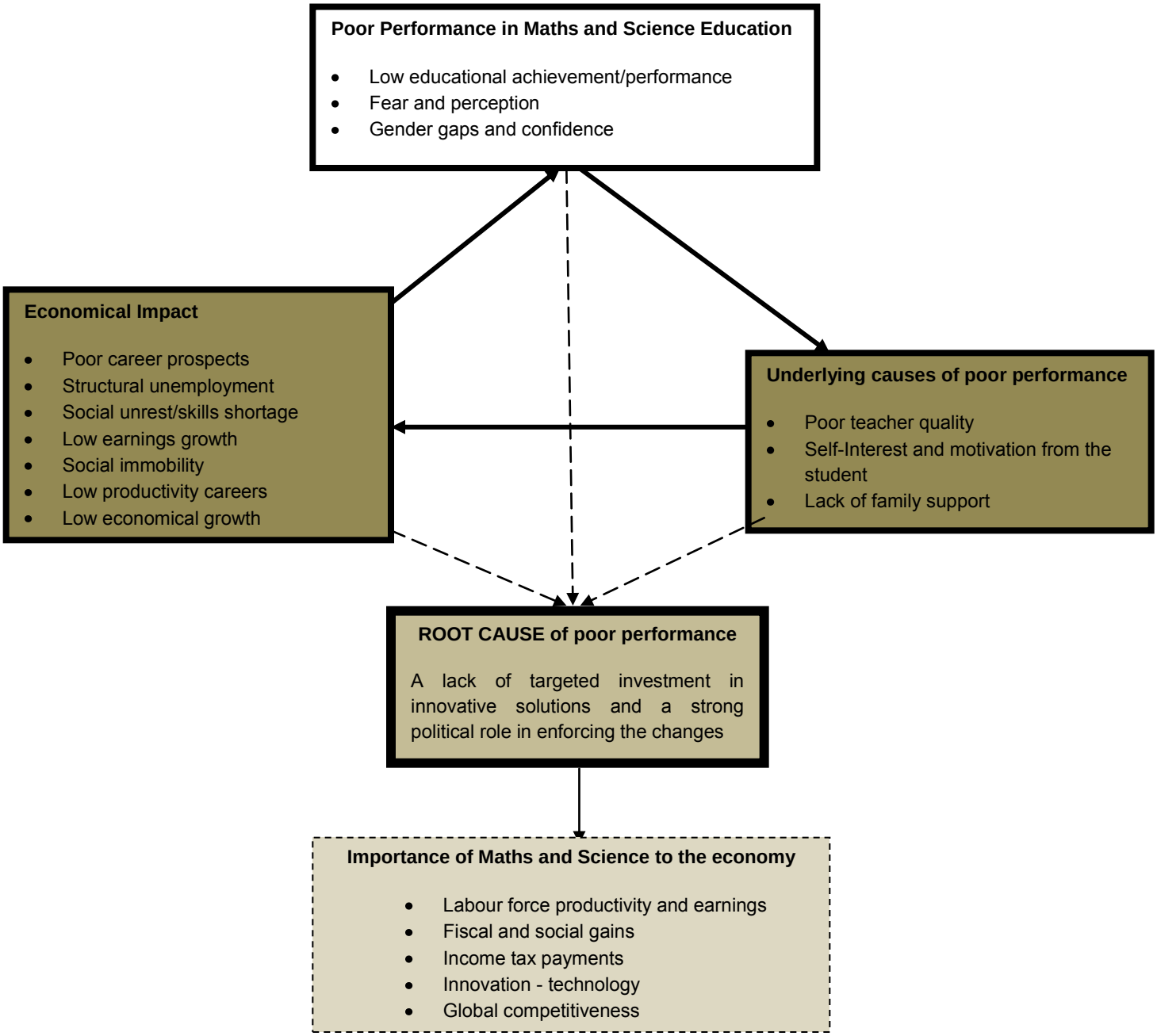
7.4 Recommendations for future research

- There is a need to prove the hypothesis that Governmental commitment and inability to innovate around solution is the “Root cause of poor performance in Maths and Science in South Africa”. This study should be conducted on a high scale in isolation to the economic consequence with a bigger population involving key governmental stakeholders in order to verify whether the results can indeed be generalized for all contexts.
- It is vital to establish the relationship between the increase of entrepreneurship businesses and the performance in Maths and Science. This research is vital since entrepreneurship stimulates employment, especially in a sector where unemployment is at 40% and entrepreneurial activities are low.
- There is a need to establish the effects of a poor quality Maths and Science teacher to the generational economical impact of the learner using a qualitative methodology. This study is from this research finding and is interesting in that it will uncover the effects of a bad teacher to a learner over time and also to his

generation. A sample of 40 year olds who had a poor education in Maths and Science could be used for consistency in results.

7.5 Model integrating all the learnings

Figure 13: Integration between the poor performance in Maths and Science education and the economic impact



7.6 Final conclusion to the research

The researches' main objective was to determine the root cause of poor performance in Maths and Science and the impact to the South African economy. The findings to the research gravitated towards the teachers as the main contributor of the poor performance but deeper investigation using the Six Sigma (5-why technique) proved that the role of government in terms of commitment and action orientated innovations could be the possible root cause of the poor performance in Maths and Science.

The economical impact of the poor performance in South Africa seemed to equate low educational attainment and poor education to the source of the economical predicament when it comes to social unrest, low productivity, structural unemployment and skills shortage to mention a few. These are factors which can be reduced and/or eliminated with the improvement of the quality of education especially in the fields of Maths and Science. Economical growth may possibly be attained when education becomes a country strategy.

The idea that Government plays an important role in ensuring economic growth, through pushing forward the agenda of education, was proved by studies conducted by Liu et al (2012) and Grek (2009) in which they gave examples in relation to China and Finland, highlighting the effect of governmental commitment and action orientated strategies. An interesting suggesting is the support of Maths and Science Academies that could prove to be beneficial to the economies, as it will bring in the knowledge about Maths and Science and can be used as a hub for practical learning and stimulation thereby increasing the understanding and interest in learning of the two subjects.

In essence, the systems that govern the education system should be complemented and strengthened by commitment and action by the governing state. South Africa needs to have a strong education strategy around teachers in Maths and Science, and the surrounding environment in order to aid the economy in its growth path.

REFERENCES

Allais, S. (2012). Will skills save us? rethinking the relationships between vocational education, skills development policies, and social policy in south africa. *International Journal of Educational Development,*

Andrews, D. R., Washington, A., Nwachukwu, S., & Yigletu, A. (2012). Influence of poverty on educational performance in louisiana: Emphasis on the mississippi delta parishes. *Southwestern Economic Proceedings, 30*, 35-44.

Andrews, J., & Clark, R. (2012). Breaking down barriers: Teenage girls' perceptions of engineering as a study and career choice.

Ashman, S., Fine, B., & Newman, S. (2011). Amnesty international? the nature, scale and impact of capital flight from south africa. *Journal of Southern African Studies, 37*(01), 7-25.

Baker, D. (2012). *The Problem with Structural Unemployment in the US,*

Bartlett, W. (2012). Structural unemployment in the western balkans: Challenges for skills anticipation and matching policies.

Boraiko, C., Beardsley, T., & Wright, E. (2008). Accident investigations one element of an effective safety culture. *Professional Safety, 53*(9)

Bradbury, J., & Miller, R. (2011). A failure by any other name: The phenomenon of underpreparedness. *South African Journal of Science, 107*(3-4), 01-08.

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*(1), 371-399.

Burris, J. E. (2012). It's the teachers. *Science, 335*(6065), 146-146.

Card, A. J., Ward, J., & Clarkson, P. J. (2012). Successful risk assessment may not always lead to successful risk control: A systematic literature review of risk control after root cause analysis. *Journal of Healthcare Risk Management, 31*(3), 6-12.

Chibba, M., & Luiz, J. M. (2011). Poverty, inequality and unemployment in south africa: Context, issues and the way forward. *Economic Papers: A Journal of Applied Economics and Policy, 30*(3), 307-315.

Chipaike, R. (2012). Zimbabwe's economic empowerment initiatives: A critical review. *Sustainable Peace and Development at Community Level: Beneficiaries are Actors Too,* , 117.

Cleghorn, A., & Rollnick, M. (2002). The role of English in individual and societal development: A view from African classrooms. *Tesol Quarterly, 36*(3), 347-372.

Coffield, F. (2012). Why the McKinsey reports will not improve school systems. *Journal of Education Policy, 27*(1), 131-149.

Curci, F., Khatiwada, S., & Tobin, S. (2012). Market turbulence, employment and social unrest: Trends and outlook. *World of Work Report, 2011*(1), 1-30.

Dempster, E. R., & Reddy, V. (2007). Item readability and science achievement in TIMSS 2003 in south africa. *Science Education, 91*(6), 906-925.

Dimmock, C. (2011). Diversifying schools and leveraging school improvement: A comparative analysis of the english radical, and singapore conservative, specialist schools' policies. *British Journal of Educational Studies, 59*(4), 439-458.

Economist. (2012, January 21). Education in South Africa still dysfunctional. *The Economist*

Govender, P., & Gruzd, S. (2011). *Back to the blackboard: Looking beyond universal primary education in africa* South African Institute of International Affairs (SAIIA).

Grek, S. (2009). Governing by numbers: The PISA ‘effect’in europe. *Journal of Education Policy, 24*(1), 23-37.

Hickling‐Hudson, A. (2004). South–south collaboration: Cuban teachers in jamaica and namibia. *Comparative Education, 40*(2), 289-311.

Kanyenze, G., & Lapeyre, F. (2012). Employment sector employment working paper no. 81.

Keble, J. A. (2012). *An Investigation into the Low Pass Rate in Science and Mathematics in Selected Schools in the Northern Areas, Port Elizabeth,*

Kleynhans, E. P. J., & Labuschagne, J. R. (2012). Human capital constraints in south africa: A firm-level analysis. *Managing Global Transitions, 10*(1 (Spring)), 69-86.

Liu, X., Liang, L. L., & Liu, E. (2012). Science education research in china: Challenges and promises. *International Journal of Science Education, 34*(13), 1961-1970.

Lucas, A. M., & Mbiti, I. M. (2012). Does free primary education narrow gender differences in schooling? evidence from kenya. *Journal of African Economies,*

Mabila, T., Malatje, S., Addo-Bediako, A., Kazeni, M., & Mathabatha, S. (2006). The role of foundation programmes in science education: The UNIFY programme at the university of limpopo, south africa. *International Journal of Educational Development, 26*(3), 295-304.

Maree, J. (2008). Why maths counts. *Quest, 493*, 38-45.

McGrath, S., & Akoojee, S. (2007). Education and skills for development in south africa: Reflections on the accelerated and shared growth initiative for south africa. *International Journal of Educational Development, 27*(4), 421-434.

Mji, A., & Makgato, M. (2006). Factors associated with high school learners' poor performance: A spotlight on mathematics and physical science. *South African Journal of Education, 26*(2), 253-266.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods, 1*(2), 13-22.

Ndlovu, M. C. (2011). University-school partnerships for social justice in mathematics and science education: The case of the SMILES project at IMSTUS. *South African Journal of Education, 31*(3), 419-433.

O'Dea, J. A., & Mugridge, A. C. (2012). Nutritional quality of breakfast and physical activity independently predict the literacy and numeracy scores of children after adjusting for socioeconomic status. *Health Education Research,*

O'Sullivan, M. C., Wolhuter, C. C., & Maarman, R. F. (2010). Comparative education in primary teacher education in ireland and south africa. *Teaching and Teacher Education, 26*(4), 775-785.

Ozturk, Ilhan, 2001. The role of education in economic development: a theoretical perspective, MPRA Paper 9023, *University Library of Munich*, Germany.

Pande, P. S., Holpp, L., & Pande, P. (2002). What is six sigma?

Probyn, M. (2009). 'Smuggling the vernacular into the classroom': Conflicts and tensions in classroom codeswitching in township/rural schools in south africa. *International Journal of Bilingual Education and Bilingualism, 12*(2), 123-136.

Rasool, F., & Botha, C. J. (2011). The nature, extent and effect of skills shortages on skills migration in south africa. *SA Journal of Human Resource Management, 9*(1), 12 pages.

Reddy, V., Kanjee, A., & Diedericks, G. (2007). *Mathematics and science achievement at south african schools in TIMSS 2003* Human Sciences Research Council.

Rimmell, S. (2008). *The consumer-brand relationship amongst low-income consumers*. University of Pretoria, Pretoria.

Romagnolo, D., & Anderson, N. (2010). Cyscience: Emerging technologies for rural PD. *ACEC2010: Digital Diversity Conference,* 1-9.

Rubb, S. (2006). Educational mismatches and earnings: Extensions of occupational mobility theory and evidence of human capital depreciation. *Education Economics, 14*(2), 135-154.

Ryan, G. (2012). *A Comparison of Enterprise Development Models in South Africa using Case Studies,*

Satgar, V. (2012). Confronting climate catastrophe: The south african climate jobs campaign. *The Second ISA Forum of Sociology (August 1-4, 2012),*

Simkins, C. (2011). The jagged tear: Human capital, education and AIDS in south africa, 2002-2010.

Simkins, C., Rule, S., & Bernstein, A. (2009). Doubling for growth: Addressing the maths and science challenge in south africa's schools.

Tatira, B., Mutambara, L., & J Chagwiza, C. (2012). The balobedu cultural activities and plays pertinent to primary school mathematics learning. *International Education Studies, 5*(1), p78.

Thawani, S. (2004). Six sigma—strategy for organizational excellence. *Total Quality Management & Business Excellence, 15*(5-6), 655-664.

Tullock, Z. (2010). *Capital constraints to entrepreneurial start-ups in South Africa's emerging agribusiness industry*. University of Pretoria, Illovo.

United Nations. 2010. Human Development Report 2010, The Real Wealth of Nations: Pathways of Human Development. New York: *United Nations Development Programme*, 2010.

University of Wisconsin - Milwaukee (2008, September 8). Tracking The Reasons Many Girls Avoid Science And Math. *ScienceDaily*

Venkat, H., Adler, J., Rollnick, M., Setati, M., & Vhurumuku, E. (2009). Mathematics and science education research, policy and practice in south africa: What are the relationships? *African Journal of Research in Mathematics, Science and Technology Education, 13*, 5-27.

Verick, S. (2012). Giving up job search during a recession: The impact of the global financial crisis on the south african labour market. *Journal of African Economies, 21*(3), 373-408.

Vithal, R., & Bishop, A. J. (2011). Mathematical literacy: A new literacy or a new mathematics? *Pythagoras,* (64), 2-5.

Wadesango, N., & Dhliwayo, E. (2012). Study of secondary schools students performance in mathematics from zimbabwe. *Anthropologist, 14*(2), 113-121.

Wildsmith-Cromarty, R., & Gordon, M. (2009). Policy versus practice: The role of the home language in learning mathematics and science in english-medium classrooms. *Language Learning Journal, 37*(3), 359-370.

Willard, N., Chutuape, K., Stines, S., Ellen, J. M., & The Adolescent Medicine Trials Network for HIV/AIDS Interventions. (2012). Bridging the gap between individual-level risk for HIV and structural determinants: Using root cause analysis in strategic planning. *Journal of Prevention & Intervention in the Community, 40*(2), 103-117.

Xu, W., & Yang, L. (2011). A study on the contribution rate of investment in education in china to the economic growth. *Information Management, Innovation Management and Industrial Engineering (ICIII), 2011 International Conference on, , 1* 176-179.

Yusuf, M., & Oluwaseun, O. (2012). INVESTMENT IN EDUCATION AS A MEANS OF ECONOMIC DEVELOPMENT. *BOOK OF,* , 249.

Appendix A: Past Learner's Questionnaire

Letter of informed Consent

September 2012

Organisation

Attention: Mr./Ms./Mrs./Dr./Prof.

Title:

Fax:

APPLICATION FOR CONDUCTING RESEARCH AS PART OF MY MASTERS DEGREE IN BUSINESS ADMINISTRATION

I am a Masters student of the University of Pretoria, Gordon Institute of Business Science (GIBS) specializing in Business Administration. Part of my degree includes the completion of relevant and factual research. I plan on a business in education and I am particularly interested in the Maths and Science discipline. The title of my research project is: *Exploring the root cause of poor performance in Maths and Science and the impact to the South African economy.* The main research question is: *What is the underlying cause of failure in Maths and Science education in South African Schools and the economic impact thereafter?*

In order for me to collect data, I will be sending out a questionnaire with previous maths and science learners, scope is limited to those who did Maths and Science up to any level and would find your views extremely valuable and most beneficial for the research. I have attached the suggested set of questions for the questionnaire that I will conduct, which I hope will be valuable for you in thinking about this prior to my visit if a need arises. I

assure you that I would not take more than 45-60 minutes of your time and that the information that you may give me will be credited to you in the report that I will subsequently write.

Please remember that the research is voluntary. If you don't want to take part in the research due to any issues, you can withdraw at any time and the withdrawal will not result in any consequences or penalty. All the information will be treated as confidential and you will remain anonymous. This is an academic research, hence there will be no remuneration or any costs to yourself if you choose to participate in the questionnaire.

If, as I hope you are able to assist, please sign the letter as a consent and read below for instructions on how to complete the attached questionnaire.

If you have any questions and/or concerns regarding the research itself, please talk to me or my supervisor.

Bridget Banda
Bridget.banda@gmail.com
071 606 6133

Johan Lamprecht
Johan.Lamprecht@yahoo.com
083 262 7244

I as the participant consent to filling in this questionnaire, Please Mark with an (X). 

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Instructions for completing Maths and Science Questionnaire

The following information about the Poor performance in Maths and Science and the impact to the South African economy is being collected by Bridget Banda for the purposes of an MBA with Gordon Institute of Business Science. For the purpose of this questionnaire, this target group includes:

- People who did Maths and/or Science in High School
- People who attempted and/or dropped out of Maths and/or Science
- People who passed or failed Maths and/or Science
- 18 years and older

The questionnaire enclosed is a MS Word document which can be:

1. Printed, completed manually then faxed or scanned to Bridget.banda@gmail.com, 086 542 6030 or completed manually and inform Bridget Banda via e-mail to collect.
2. If you prefer to complete it electronically:
    - Save the questionnaire to your hard drive
    - Close the e-mail and open to complete the questionnaire by marking with a black (X) in the red shaded areas.
    - Once complete, save the changes and return to Bridget.banda@gmail.com before the 14th of September 2012.
3. If at any time you encounter problems with the questionnaire, please contact me on Bridget.banda@gmail.com, 071 606 6133 and/or nkunabw@gmail.com.

Please answer all questions as they apply to the Maths and Science questionnaire, if there are people you know who meet the target market as stated above do not hesitate to forward to them as well. The information collected will be used only for the purpose of the Maths and Science questionnaire and the participant will enjoy anonymity and confidentiality.

Your cooperation in completing this questionnaire will greatly contribute to the house of knowledge in uncovering the root cause of Maths and Science failure and the economic impact.

Questionnaire: Exploring the root cause and economic impact of poor performance in Maths and Science

Please fill out the following details concerning performance in maths and science by filling in an (X) in the red box on the right.

A. Demographic and Background information

1. In which age range do you fall in?

18-21 years	
22-25	
26-30	
31-40	
41-50	
50-60	
61 or over	

2. Are you male or female?

Male	
Female	

3. What is the highest level of education you have completed?

Less than high school	
High school/Matric/Grade 12	
Incomplete Certificate/Diploma/Degree	
Certificate/Diploma	
3 - 4year Bachelors degree	
Honours degree	
Masters degree	
Doctoral degree	
Other (please specify):	

4. What is your home language

English	
Afrikaans	
Xitsonga	
SePedi	
SeSotho	
SeTswana	
IsiXhosa	
Tshivenda	
IsiSwati	
IsiNdebele	
isiZulu	

5. Which business sector are you employed or conducting business in?

Aerospace and Defence		Construction & Materials		Forestry and Paper	
Agriculture and Agri-processing		Containers & Packaging		Healthcare and pharmaceuticals	
Aquaculture and Mariculture		Delivery services/logistics		ICT-information & communication Technology	
Automobiles		Development Finance		Insurance	
Banking		Education		Manufacturing	
Boat building		Electronics		media	
Chemicals		Energy		Mining and metals	
Clothing and textile		Environment and Waste		Oil and Gas	
Personal & Household Goods		Retail		Telecommunications	
Public Sector Entity		Sport		Tourism & leisure	
Transportation		Utilities		Water	

6. What is your yearly salary, not including bonuses? (this question is optional)

Less than R20000	
R200 000 – R300 000	
R300 001 - R400 000	
R400 000 – R500 000	
R500 001 – R600 000	
R600 001 – R800 000	
R800 001 – R1000 000	
R1 000 001 –R1 200 000	
More than R1 200 001	

7. Have you ever done Maths and/or Science as a subject/s in High school?

Yes	
No	

8. If answered yes (Question 7) above, please specify up to what Grade/Standard?

Grade 8/ Standard 6	
Grade 9/ Standard 7	
Grade 10/ Standard 8	
Grade 11/ Standard 9	
Grade 12/ Standard 10/ Matric	

9. If Maths and/or science were done up to Grade 12/Standard 10/Matric, did you pass or fail? Please specify whether subject was passed or failed. Please mark with an (X) in the appropriate field.

Subject	**Pass** [more than 40%(E) at Higher Grade (HG) or Standard Grade (SG)]	**Fail** [Less than 40%(E) at Higher Grade (HG) or Standard Grade (SG)]
Maths/Maths literacy		
Science		

10. Are you satisfied with your overall Maths and Science results?

Yes	
No	
I don't know	

11. Which province were you educated in?

Primary school	Mark with an (X)	**High school**	Mark with an (X)	**Tertiary**	Mark with an (X)
Limpopo		Limpopo		Limpopo	
Gauteng		Gauteng		Gauteng	
Eastern Cape		Eastern Cape		Eastern Cape	
Western cape		Western cape		Western cape	
Kwazulu-Natal		Kwazulu-Natal		Kwazulu-Natal	
North west		North west		North west	
Mpumalanga		Mpumalanga		Mpumalanga	
Northern cape		Northern cape		Northern cape	
Free state		Free state		Free state	

12. Describe the Place of your birth?

Urban (City or town)	
Rural (Countryside)	

13. What was your dream career/job growing up?

14. Who were your Maths and/or Science role models growing up?

15. Highest level of education your parents/Guardian has completed?

	Mother	Father	Guardian
Less than high school			
High school/Matric/Grade 12			
Incomplete certificate/diploma/degree			
3 - 4year Bachelors degree			
Honours degree			
Masters degree			
Doctoral degree			
Other (please specify):			

B. Please answer (Yes or No) to the following questions.

	Yes (Mark with an X)	**No** (Mark with an X)
1. Are Maths and/or Science difficult?		
2. Did your parents/guardian know maths and science?		
3. Were your teachers and/or school knowledgeable in Maths and/or Science?		
4. Did you understand what was being taught in the Maths and/or Science class?		
5. Did your school offer any additional help in Maths and/or Science?		

C. Please answer the following questions with an (X) under the number which most describes your feeling.

Assess to what extent language of instruction, teachers literacy, curriculum content and availability of materials affected you Maths and/or Science performance outcome.	Not at all				To a large extent	
1. To what extent did the language of instruction affect your Maths and/or science performance	**1**	**2**	**3**	**4**	**5**	**Your Comments:**
2. To what extent did the teachers literacy affect your Maths and/or Science performance	**1**	**2**	**3**	**4**	**5**	**Your Comments:**
3. To what extent did the availability of learning materials affect your Maths and/or Science performance	**1**	**2**	**3**	**4**	**5**	**Your Comments:**
4. To what extent did the curriculum content affect your Maths and/or Science performance	**1**	**2**	**3**	**4**	**5**	**Your Comments:**

D. Please note that the following questions are open-ended. Kindly provide as much details as possible.

16. What is your impression/feeling towards maths and/or science?

17. What do you think was the reason for your performance (Pass or fail) in maths and/or science?

18. Please elaborate (question 17) as to why this was the reason for the performance (Pass or fail) in maths and/or science?

19. How did your maths and/or science teacher influence your performance (Pass or fail) in maths and/or science?

20. How has your performance (Pass or fail) in maths and/or science influenced your life so far?

21. How would your life have changed if your maths and/or science performance (pass or fail) was different?

22. Please describe the availability of Maths and/or Science learning materials (e.g. textbooks, science lab, study guides, chairs and desks, writing books, library…) in your school?

23. What role do you think Maths and Science plays in society? What is the importance of maths and science in the economy?

24. What do you think should change (Teachers, curriculum, government, and student) in order to ensure a high performance in Maths and Science?

25. Any additional information that you would like to add?

The End….

Thank you for your patience.

"If you don't ask the right questions, you don't get the right answers. A question asked in the right way often points to its own answer. Asking questions is the ABC of diagnosis. Only the inquiring mind solves problems." — Edward Hodnett

Appendix B: Experts Questionnaire

Letter of informed consent

September 2012

Organisation

Attention: Mr./Ms./Mrs./Dr./Prof.

Title:

Fax:

APPLICATION FOR CONDUCTING RESEARCH AS PART OF MY MASTERS DEGREE IN BUSINESS ADMINISTRATION

I am a Masters student of the University of Pretoria, Gordon Institute of Business Science (GIBS) specializing in Business Administration. Part of my degree includes the completion of relevant and factual research. I plan on a business in education and I am particularly interested in the Maths and Science discipline. The title of my research project is: *Exploring the root cause of poor performance in Maths and Science and the impact to the South African economy.* The main research question is: *What is the underlying cause of failure in Maths and Science education in South African Schools and the economic impact thereafter?*

In order for me to collect data, I will be sending out Questionnaires to experts and specialists in the education sector, Maths and Science career streams and economists and would find your views extremely valuable and most beneficial for the research. I have attached the suggested set of questions for the questionnaire that I will conduct. I assure

you that I would not take more than 30-45 minutes of your time and that the information that you may give me will be credited to you in the report that I will subsequently write.

Please remember that the research is voluntary. If you don't want to take part in the research due to any issues, you can withdraw at any time and the withdrawal will not result in any consequences or penalty. All the information will be treated as confidential and your identity will remain anonymous. This is an academic research and there will be no remuneration or any costs to yourself if you choose to participate in the questionnaire.

If, as I hope you are able to assist, please sign the letter as a consent and read below for instructions on how to complete the attached questionnaire.

If you have any questions and/or concerns regarding the research itself, please talk to me or my supervisor.

Bridget Banda
Bridget.banda@gmail.com
071 606 6133

Johan Lamprecht
Johan.Lamprecht@yahoo.com
083 262 7244

I as the participant consent to filling in this questionnaire, Please Mark with an (X). 

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Instructions for completing Maths and Science Questionnaire – Experts

The following information about the Poor performance in Maths and Science and the impact to the South African economy is being collected by Bridget Banda for the purposes of an MBA with Gordon Institute of Business Science. For the purpose of this questionnaire, this target group includes:

- Experts in Education
- Socio-economic specialist
- Specialists in the Maths and Science career streams

The questionnaire enclosed is a MS Word document which can be:

4. Printed, completed manually then faxed or scanned to Bridget.banda@gmail.com, 086 542 6030 or completed manually and inform Bridget Banda via e-mail to collect.
5. If you prefer to complete it electronically:
    - Save the questionnaire to your hard drive
    - Close the e-mail and open to complete the questionnaire by marking with a black (X) in the red shaded areas.
    - Once complete, save the changes and return to Bridget.banda@gmail.com before the 14th of September 2012.
6. If at any time you encounter problems with the questionnaire, please contact me on Bridget.banda@gmail.com, 071 606 6133 and/or nkunabw@gmail.com.

Please answer all questions as they apply to the Maths and Science questionnaire, if there are people you know who meet the target market as stated above do not hesitate to forward to them as well. The information collected will be used only for the purpose of the Maths and Science questionnaire and the participant will enjoy anonymity and confidentiality.

Your cooperation in completing this questionnaire will greatly contribute to the house of knowledge in uncovering the root cause of Maths and Science failure and the economic impact.

Questionnaire: Exploring the root cause and economic impact of poor performance in Maths and Science (Experts)

Please fill out the following details concerning performance in maths and science by filling in an (X) in the yellow box on the right.

1. What is the name of the institution that you represent?

2. What is your designation?

3. Which sector are you employed or conducting business in? Please mark with an X in the orange box.

Aerospace and Defence		Construction & Materials		Forestry and Paper	
Agriculture and Agri-processing		Containers & Packaging		Healthcare and pharmaceuticals	
Aquaculture and Mariculture		Delivery services/logistics		ICT-information & communication Technology	
Automobiles		Development Finance		Insurance	
Banking		Education		Manufacturing	
Boat building		Electronics		media	
Chemicals		Energy		Mining and metals	
Clothing and textile		Environment and Waste		Oil and Gas	
Personal & Household Goods		Retail		Telecommunications	
Public Sector Entity		Sport		Tourism & leisure	
Transportation		Utilities		Water	

4. What are the underlying problems in the **poor performance** of Maths and Science education?

5. How does poor educational outcome link up to the **socio-economic problems** in South Africa?

6. Is education the primary cause of structural **unemployment** in South Africa and if so how can this be resolved?

7. What is the economical impact of youths with low educational levels being trapped in **low productivity** jobs?

8. What is the relationship between low level education and **social unrest**?

9. The demand for people with high-quality skills and qualifications is on the rise, how does the poor performance in Maths and Science affect the **skills/resources shortage** and the growth of the economy?

10. How does low educational achievement lead to **low earnings growth/low tax income** and how does this affect the economy overall?

11. What is the return to **investment** in education, especially Maths and Science?

12. What needs to be done in South Africa to improve the performance of Maths and Science education?