Deriving Norms for learners in the disadvantaged schools of the peri-urban areas of the Eastern Cape: The case of the Vassiliou Mathematics Proficiency Test (VASSI)

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of the requirements for the degree of

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by

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DECLARATION

I declare that the Dissertation/Thesis entitled, Deriving Norms for learners in the disadvantaged schools of the peri-urban areas of the Eastern Cape: The case of the Vassiliou Mathematics Proficiency Test (VASSI), which I hereby submit for the degree, Masters of Arts in Clinical Psychology at Rhodes University, is my own work. I also declare that this thesis/dissertation has not previously been submitted by me for a degree at this or any other tertiary institution and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Siphesihle Polkadot Masango

DEDICATION

To my mother Wandisa Vaudette Katie Masango and late father Foto Lennox Mangesi

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I would like to express my thanks and appreciation to:

God for His unmerited favour and endless blessings

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ABSTRACT

This study builds on South African cross-cultural research which highlights the need for careful stratification of normative samples for quality of education and geographical location. The aim of the present study was to produce an expanded set of preliminary norms for learners in the disadvantaged schools of the peri-urban areas of the Eastern Cape, Grahamstown, on the Vassiliou Mathematics Foundation Phase Test (VASSI) and Vassiliou Mathematics Proficiency Test (VASSI), respectively. The test was administered to Grade 1-6 learners in four different schools all within Joza location, Grahamstown. For the learners' convenience the tests were translated into isiXhosa, the translations were provided together with the original English questions. Archival data collected by honours students was also incorporated in this study. The total number of participants was N=724 which was comprised of 147 grade 1s, 123 grade 2s, 117 grade 3s, 128 grade 4s, 113 grade 5s and 96 grade 6s. Norm-referenced criterion was used in analysing the data. The results of this study are in accordance with those purporting the low performance of disadvantaged learners on the school subject, mathematics. Stanines for the various grades (Grade 1 to 6) were calculated and are presented in the study. This study has demonstrated that although gender, language and other ethnic variables have an impact on mathematics performance, quality of education and socioeconomic status have a significant effect. Further research is needed on the effect of quality of education and socioeconomic status on learners in disadvantaged schools on this test in particular.

Keywords: VASSI norms, mathematics proficiency, Eastern Cape, quality of education, disadvantaged schools, socioeconomic status

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LIST OF ABBREVIATIONS

(ANA) Annual National Assessment

(CF) Cumulative Frequency

(DET) Department of Education and Training

(M) Mean

(MLA) Monitoring Learning and Achievement

(N) Number of people in the distribution

(NCE) Normal Curve Equivalent

(NSNP) National School Nutrition Programme

(PCK) Pedagogical Content Knowledge

(PR) Percentile Rank

(SACMEQ) Southern African Consortium on Monitoring Education Quality

(SAT/GRE) SCholastic Assessment Test and Graduate Record Examination

(SES) Socioeconomic Status

(SD) Standard Deviation

(TIMMS) Trends in International Mathematics and Science Study

(VASSI) Vassiliou Mathematics Proficiency Test

(WAIS-IV) Weschler Adult Intelligence Scale- Fourth Edition

(WISC-IV) Weschler Intelligence Scale for Children

(X) Raw Score

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In 2000, counselling psychologist, Dr. Colleen Vassiliou created a mathematics norming test following the expressed interest of mathematics teachers in the Free State region of South Africa. This mathematical norming test was created and standardised using a sample of primary school aged children with the aim of identifying mathematical problems in these learners (Vassiliou, 2000). The Vassiliou Mathematics Proficiency Test (VASSI) test is currently used by psychologists, teachers and psychometrists in South Africa. Since the original norming phase of the VASSI is largely based on a sample of children from the Free State, with a unique social, educational and economic contexts; there has been a strong need to standardize this psychometric test in the Eastern Cape, with its unique educational and economic challenges (more on this in the following section). In the subsequent sections I further lay the context and background to my research on creating adequate norms of the VASSI in the Eastern Cape region.

1.2 PROBLEM STATEMENT

Cicchetti (1994) defines norms as the average score or the average performance of a standardisation sample. According to Vassiliou (2000), before norming and standardisation can be done, psychological testing needs to take place. Although there have been a number of critiques that pertain to psychological testing such as that psychological tests are (a) not accurate enough with regard to selection, guidance and placement purposes, (b) that they do not accurately predict psychological states and that they (c) are culturally biased (Foxcroft, 1997); some advantages of psychological tests have been noted (Foxcroft, 1997). For instance, Foxcroft (1997) has pointed out that there has been a move away from the “unitary testing method” towards a more comprehensive and multi-method form of assessment. This is to say that when testing, researchers should bear in mind that test results are only a small part of the information, other sources of information should be approached and the testee’s context should be kept in mind in order to gain a more meaningful understanding regarding psychological assessment findings (Foxcroft, 2011).

With regard to norming, the South African Constitution promotes fairness and equality, and has influenced a move towards culturally fair and unbiased psychometric testing (Foxcroft, 1997). One of the many ways to ensure fairness is through the development and adaptation of culturally relevant norms. According to Foxcroft (1997):

> *“There is thus an urgent need to develop and norm culturally appropriate tests for the South African population, as this will generally enhance the fair and ethical use of tests.” (Foxcroft, 1997, p.231).*

A recent paper by Shuttleworth-Edwards (2016) has called into question the practice of population norming. For the diversified context of South Africa, “demographically focused” norms are more appropriate (Shuttleworth-Edwards, 2016, p.4).

Based on Foxcroft (1997), Shuttleworth-Edwards (2016) and other standardisation scholars’ views on standardisation samples but more so on the state of education in the Eastern Cape (levels of mathematics results), the need to derive VASSI norms according to geographical location and quality of education is quite pertinent.

1.3 RESEARCH AIMS

Emanating from the insights of Foxcroft (1997) as cited above was the aim of this research which was to create norms based on the unique geographical location of

Grahamstown, located in the Eastern Cape. Below, I further expand on this unique geographical locale. More specifically, the primary purpose of my research was to generate, and provide preliminary norms for grade one to six learners attending township schools in Grahamstown, based on the VASSI.

1.4 OVERVIEW

There are six chapters in this study, each with a different focus area. In the literature review (Chapter 2) I briefly review relevant literature related to my topic including, (a) barriers related to teaching and learning in South Africa. (b) The state of mathematics education in South Africa and lastly, (c) the need to create geographically relevant norms are explored. The third chapter outlines the methods used to achieve my research aims. Chapter 4 presents my results. In Chapter 5, I discuss my results in relation to the outlined literature and make recommendations for future research.

CHAPTER TWO

LITERATURE

2.1 EDUCATION AS A BARRIER TO LEARNING

2.1.1 Introduction. Although focusing on other forms of barriers to learning, the first section of this chapter focuses on the quality of education of South African township schools.

2.1.2 A Brief History of South African Education. One of the discriminatory legacies of the apartheid system is that of racial division in South African schools (Asmal & James, 2001; Bernstein, 2014; Reddy, 2005). Black[1] learners, who were and still are the majority in South African schools, were (during the apartheid era) denied equal learning opportunities to white[2] learners (Badat & Sayed, 2014; Carnoy & Chisholm, 2008). As a result of the apartheid legacy, Bantu education deliberately excluded mathematics and science in the township schools since black students were trained to be conduits of cheap labour for the country (Asmal & James, 2001). An example of this inequality is captured in the fact that in 1982, the apartheid government spent R146.00 on a black student's education

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[1] The author recognises the sensitivity of using terms such as 'Black' and 'White' in describing the different races of South Africa. However, these terms, as well as the other such as 'Coloured' and 'Indian', are terms widely used in academic literature to denote the various racial groups. These terms are further being used in the South African Constitution for the same purposes. According to Chapter 1 of the Employment Equity Act, No. 55 of 1988 'Black' is a generic term used in reference to Africans, Coloureds and Indians

[2] According to the Populations Registration Act of 1950 a White person is one who is of European descent.

whilst spending R1211.00 on a white student (Badat & Sayed, 2014). Under the apartheid regime there were a number of racially defined departments of education, each department provided different types and qualities of education (Spaull, 2012; Letseka, 2013). According to Spaull (2012) the type and quality of education provided was based on the role that each racial group was seen to play within society. Under the then Department of Education and Training (DET) black schools, compared to their white counterpart schools, lacked in resources and had a different syllabus and examination system (Nell, 1999; Shuttleworth-Edwards et al., 2004).

2.1.3 Education Post-Apartheid. Post-apartheid, the social, economic and political integration of South Africa was deemed most important in the country's agenda (Spaull, 2012). The government's task was to widely cast the nets of service delivery so as to reach the poor people, reduce unemployment, and facilitate economic growth (Spaull, 2012). In order to achieve this and foster a sense of social cohesion a number of steps were taken to ensure integration in South African schools (Spaull, 2012). One of these steps included doing away with the racially motivated departments and instead implementing the nine provincial Departments of Education which function under the umbrella of the National Department of Education (Spaull, 2012). Despite the many laws in the Bill of Rights (Sections 27 (1) and 29(1)) which were put in place to ensure the provision of basic services including equal education for all, social injustices are still pervasive in the South African social and economic milieu and are mostly evident in the education system (Spreen & Vally, 2006). Spaull (2012), in support of this observation, states that although the racial segregation in schools and inferior curricula were abolished, the situation in the 'township schools'[3] remained the same,

[3] Township schools are the historically black schools which are found in predominantly black communities (Msila, 2005).

and previously ‘model C’[4] schools still perform better than the aforementioned township schools (van der Berg, 2008; Letseka, 2013).

It is further worth noting that, although an increasing number of South African children have access to public education, this access has not been tantamount to obtaining quality education and the desired learner throughput (Bernstein, 2014; Motala, Dieltiens, & Sayed, 2009; Nell, 1999; Spreen & Vally, 2006). With regard to throughput, Spaull (2013) states that of the 100 learners that start in Grade 1 only 50 make it to Grade 12, and of that 50 only 40 will pass and only 12 will make it to university. In the Eastern Cape specifically (where the sample for this research comes) there were 279 933 Grade 1 learners in 2002 but only 26% wrote the matric exams in 2013 and only 17% of these learner were successful (Statistics South Africa, 2013).

2.1.4 The State of Township Schools in South Africa. As previously alluded to, the racial legacy of South African schools has been closely interlinked with the quality of education offered to various racial groups of the country. For instance, ‘township schools’, which form the majority of South African schools, are predominated by scholars from low socio-economic backgrounds. These schools face limitations such as inadequate water and sanitation facilities, as well as inadequate learning materials and a limitation of staff to name but a few (Lemon, 2004; Spreen & Vally, 2006). The above stated barriers experienced have been noted as having an adverse effect on the quality of education in such schools (Spreen & Vally, 2006). In a study conducted by Statistics South Africa (2009) (on both ‘township’ and

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[4] Model C schools are defined as the “historically white state aided schools”. Although the term is no longer an officially used term, it is used by the public as well as in academic literature when describing “historically white state schools” (Battersby, 2004).

'model c' schools) termed 'Census at School', it was found that of the 2500 schools sampled[5], 415 which were in the Eastern Cape, only 69% of the schools had a Math teacher, less than 25% had a library, 53% have a computer but only 15% had internet access. With regard to the state of township schools, Spaull (2012) summarises to say:

> *"…many of the ex-Black schools which were entirely dysfunctional under apartheid remain largely dysfunctional today. They are characterized by severe underperformance, high grade repetition, high dropout, and high teacher absenteeism…" (Spaull, 2012, p.3.)*

This finding then leads to the discussion of the specific case of the Eastern Cape, where this research was conducted.

2.1.5 Education in the Eastern Cape. In order to understand the educational outcomes of the children in the Eastern Cape, it is necessary to understand a number of variables including the socioeconomic status of the province. A report from Statistics South Africa (2013) reports that in the Eastern Cape 6 out of 10 individuals have been classified as poor with a poverty gap of 27.2%[6]. This positions the province as the second poorest (after the Limpopo Province) in the country (Statistics South Africa, 2013). Approximately a third of children in the age range of 7-18 years live without either parent (7% of these children are orphans) and more than 71% live in extended households (Statistics South Africa, 2013). The Eastern Cape maternal/paternal orphan-hood rate of 22.7% is much higher than that of the

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[5] Out of a dataset of 26 000 registered schools under 'EMIS' (Educational Management Information System) coordinated by the South African Department of Basic Education.

[6] A poverty gap (used to indicate the intensity of poverty) is the average shortfall of the population from the poverty line (Investopedia, n.d.)

national average of 18.7% for children between the ages of 7-18 years (Statistics South Africa, 2013).

Moreover, the age range for completing primary schooling in the Eastern Cape is 15, which is above that of the expected age of completion of 13 years (Statistics South Africa, 2013). Closely linked to this, 21.3 % of grade 1 learners are older than the expected age range for that specific grade and by the time they get to grade 7, 61.7% of them are older (Statistics South Africa, 2013). On average, 69% of learners in the Eastern Cape are said to be older than the expected age range per grade, when compared to the national expected age range. Thirty-eight percent (38%) of 20 year olds are still in school and only 7.4% of them are in university or in a college. From this statistic, the deduction is that at least 3 out of 10 learners will repeat at least two grades if they start school on time (Statistics South Africa, 2013). The number of people between the ages of 7-24 years in educational settings has improved in the other provinces of South Africa except for the Eastern Cape where the numbers have decreased between the 2002-2013 period (Statistics South Africa, 2013). Statistica South Africa (2013) cite a number of reasons for the low attendance of schooling in the Eastern Cape including learners stating that “education is useless”, or “poor performance” in school, “disability and illness”, as well as ‘financial constraints’ as the main reasons learners were not attending school.

2.2 POVERTY AND LOW SOCIOECONOMIC STATUS AS BARRIERS TO LEARNING

It has been argued by various authors (e.g., Bernstein, 2014; Crouch & Mabogoane, 2001; van der Berg, 2008) that children attending schools in poverty stricken areas tend to perform much lower than those in the more affluent areas. With regard to the Eastern Cape, it has been found that higher levels of deprivation in schools are associated with lower matric pass rates (Statistics South Africa, 2013). Of the 601 000 learners in the foundation phase, two out of ten are considered to be deprived (Statistics South Africa, 2016). Similarly, in the intermediate phase, over 117 000 learners are deprived (Statistics South Africa, 2016). High schools with higher pass rates are found in communities where the feeder primary schools have a high number of facilities and services and are in communities with “upper income quintiles” (Statistics South Africa, 2013).

Such children cannot attend nor focus in school on an empty stomach; or if they do not have adequate shelter and light to read at night; neither can they focus on school work if they live in fear of physical abuse, rape, harassment and crime (Spreen & Vally, 2006). Interestingly, the Eastern Cape schools have the highest occurrence of violence, physical and verbal abuse (Statistics South Africa, 2013). It is evident that poverty has a great impact on children, especially on their education, as these children have a higher likelihood to drop out of school (Statistics South Africa, 2013). The Eastern Cape has been identified as a province with a large number of families living below the poverty line. In order to address hunger as a barrier to learning the department of education launched a National School Nutrition Programme (NSNP), the Eastern Cape, with its large number of poor households was identified as the province which would most likely benefit from the programme (Statistics South Africa, 2013).

Linked to poverty and educational attainment, is the key variable of socioeconomic status (SES). According to Bradley and Corwyn (2002) SES is linked to health, cognitive, and socioemotional outcomes in children, its effects begin before birth and continue into adulthood. Children born into low SES homes are likely to experience health problems such as birth defects, disabilities, sensory impairment, asphyxia, foetal alcohol syndrome and other disabilities, these health problems stem from maternal substance abuse, poor maternal nutrition during pregnancy and poor prenatal care (Bradley & Corwyn, 2002). Health problems are associated with poor school attendance and an inability to concentrate. Premature children who live in poverty for the first three years of their lives are more likely to experience problems in behaviour and intelligence as well as growth problems and health (Bradley, Whiteside-Mansell, Mundfrom, Casey, Kelleher & Pope, 1994). McGauhey, Starfield, Alexander and Ensminger (1991) state that children who experienced perinatal problems were more prone to school failure.

Specifically with regard to low SES, cognition and mathematics, researchers have found that several components of SES, such as the family income, size of the household, mother and father education levels have a significant effect on leaners' achievement in mathematics (Crane, 2015). It is only when a mother has a degree before significant benefits are noted in a learner's mathematics scores (van der Berg, 2008). In South Africa many parents only have a basic primary school education, as such these parents are unable to assist their children with their school homework (Howie, 1997). Bradley and Crowyn (2002) in agreement with Crane (2015) state that children who come from poverty stricken homes and low parental education tend to have lower levels of achievement in school as well as lower IQs.

SES also has a significant effect on school attendance, school achievement and school dropout (Bradley & Crowyn, 2002). Bradley and Crowyn (2002) also mention the complex relationship between SES and cognition. They state that certain SES components contribute to the development of certain cognitive skills in a variety of ways and others limit the effects of other cognitive skills (Bradley & Crowyn, 2002; Hackman & Farah, 2009). In their article, Hackman and Farah (2009) boldly state that SES is linked to cognitive achievement throughout life and that it is an important predictor of cognitive achievements such as executive functioning and language. In the same article they use a number of studies which support their findings about executive functioning. These studies state that children from low SES homes are not as advanced as their peers when it comes to working memory and inhibition control. Hackman and Farah (2009) also state that 3-year-old children belonging to families with professional careers had twice as much vocabulary as those on social welfare.

Bradley and Crowyn (2002) also make note of the connection between SES and emotional and social well-being although they highlight that this connection is not as consistent as that of SES and cognitive attainment. They do however quote various researchers who maintain that children from low SES homes are more prone to showing symptoms of mental illness and maladaptive social functioning than children from more affluent homes. All these negatively affect the learner's achievement in their studies.

With regard to South Africa and the Eastern Cape, it has been found that there are two types of schooling systems and that this divide is largely along the former school system and socioeconomic lines (Spaull, 2012; 2013; van der Berg, 2008). In the more affluent schools the learners are more likely to live in urban areas, speak English at home more frequently and have more educated parents (Spaull, 2012). These learners are also more likely to own textbooks (Spaull, 2012). In his paper, van der Berg (2008) listed a number of factors which had an effect on learners' performance at school, these included: SES, location of the school and its resources, availability of textbooks, learner demographics, learner behaviour, school attendance, grade repetition and health, teacher characteristics as well as parental education amongst others. SES was found to play a major role in the achievement of primary school learners in South Africa (van der Berg, 2008).

2.2.1 Socioeconomic Status and Mathematics Achievement. Singh's (2015) study of the most prominent predictors of Hawaiian children's achievement in mathematics showed that individual characteristics have four times more impact than those of schools. Furthermore, the study concluded that Grade 3 mathematics achievement was the most important predictor of future achievement in the subject. They also found that a low SES has a negative impact on learner achievement (Singh, 2015). A similar study in America done by Payne and Biddle (1999) suggests that child poverty and poor school funding have an impact on a learner's achievement in mathematics. They further add that although learner's poor performance in mathematics has been pinned onto "school curricula", "educators" and "lack of standards" (p. 10), low socioeconomic levels and poorly funded schools is a more plausible explanation (Payne & Biddle, 1999).

The above then leads to a brief outline of mathematics education in South Africa and the Eastern Capes.

2.3 STATE OF MATHEMATICS EDUCATION IN SOUTH AFRICA

2.3.1 Mathematics Defined. According to Kapp as cited by Vassiliou (2000) mathematics is a field which relies on inductive and deductive reasoning to find solutions to various problems. It includes algebra, geometry, trigonometry, statistics and arithmetic. The Department of Basic Education (2011) defines mathematics as:

> *"Mathematics is a language that makes use of symbols and notations for describing numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental*

> *processes that enhance logical and critical thinking, accuracy and problem-solving that will contribute to decision-making" (Department of Basic Education, 2011, p.8).*

2.3.2 South African Learners' Mathematics Achievement. International tests such as the Trends in International Mathematics and Science Study (TIMMS), Monitoring Learning Achievement (MLA) and the Southern African Consortium on Monitoring Education Quality (SACMEQ), show that the quality of education in South African schools is behind even that of schools in poorer countries (Bernstein, 2014; van der Berg, 2008). The *Trends in International Mathematics and Science Study* (TIMSS) was an international study of mathematics and sciences done during the 1995-2011 period. The study compared mathematics and science scores of grade 8 pupils in middle income countries. In 2002 TIMSS South Africa tested both grade 8 and grade 9 learners as earlier rounds of the study indicated that the international grade 8 test was too difficult for the grade 8 learners of South Africa (Spaull, 2013). In 2011 TIMMS South Africa permitted only the grade 9 learners to take part in the study (McCarthy & Oliphant, 2013). In this study, South African pupils were found to be the most poorly performing (Bernstein, 2014; Reddy, 2005). In 2003 the learners obtained the lowest score of the 46 participating countries. In mathematics they scored a total of 264 with the international mean at 467 and in science they scored 244 whilst the international mean was 474 (van der Berg, 2008). According to Reddy (as cited by van der Berg, 2008) the former model C schools performed at the international mean level, whilst the township schools performed at a level less than half the international mean level. As previously mentioned language plays a role in mathematics achievement. The TIMMS also revealed that in terms of mathematical performance, South African grade 9 pupils are two years' worth of education behind grade 8 pupils in 21 middle income countries (Bernstein, 2014). According to Reddy (2005) and others (e.g., Bernstein, 2014; Lemon, 2004; Motala et al., 2009) the above cited factors negatively affect the low resourced leaners' participation and achievement in mathematics, amongst other subjects. Furthermore, the Annual National Assessment (ANA) results of 2012 showed that grade 9 pupils belonging to the poorest 40% of South African schools are three years behind those in the 20% more affluent schools (Bernstein, 2014).

Furthermore, Bernstein's (2014) paper, shows that by the time low resourced pupils reach grade 9 they are already far behind in terms of curriculum achievement with an average mathematics score of 13%. Only 8.1% of tested grade 9 pupils in the poorest 40% of South African schools reached the 33% pass mark and only 2.2% reached the previously set 50% pass mark (Bernstein, 2014).

According to Howie (1997) in her report on South African learners' performance in the TIMMS conducted in 1995 on grades 4, 5, 7, 8, and matric learners, the majority of the learners wrote the tests in a language which was not their mother tongue. In the same paper, Howie (1997) mentions several other findings which are important for this study. These include: 1) South African pupils showed "inadequate problem-solving techniques"; 2) they have difficulty constructing their own answers; 3) the amount of mathematics and science homework reported by the learners was lower than that of the international mean; 4) South African learners have shorter classroom learning time; 5) South Africa had the second oldest learners (after Colombia), the average age of learners in grade 7 was 13,9 years and in grade 8 was 15,4 years.

Although socioeconomic statuses play an important role in school performance, the above study showed that this was not the main determinant factor. In the same study there were other countries from Africa with much lower socioeconomic statuses, however these contries performed better than South Africa. The report cited the quality of education received as the major problem contributing to below par mathematics performance in South Africa. On the same trajectory Letseka (2013) states that although South Africa has a better economy than countries like Botswana, Kenya, Mauritius and Zimbabwe these countries outperformed South Africa on international studies. He further states that the reason for this is because such countries understand the importance of hiring qualified teachers and invest in these teachers by providing them with environments which allow them to spend more time in the classroom (Letseka, 2013).

Hoadley (2007) in her study of the mathematical differences in the middle class and working class schools found that in the middle class schools mathematical knowledge was strongly linked to every day knowledge however this was not the case in the working class schools. In these schools children employed a number of strategies which weakly represented the relationship between school knowledge and everyday knowledge (Hoadley, 2007). The mathematical tasks set for these learners were “emptied of mathematical content” and the strategies they employed in solving these tasks were concrete in nature (Hoadley, 2007). In the middle class schools children used more mathematical procedures such as “quick mental calculations” when working out answers (Hoadley, 2007)

2.3.3 Numeracy in the Eastern Cape and Free State. The Annual National Assessments (ANA) are national assessments of numeracy and literacy which are standardised for all pupils in grades 1-7 and 9 (Department of Basic Education, n.d.; Statistics South Africa, 2013). The Department of Basic Education (n.d.), the creators of the ANA, define numeracy as “the ability to reason with numbers and mathematical concepts such as addition and subtraction” and literacy as “the ability to read for knowledge, write logically, communicate verbally and think critically about printed material”. The aim of the ANA is “to improve the mathematic and language levels of learners” by establishing the level at which learners are performing and using this information to determine whether extra lessons are needed (Department of Basic Education, n.d.). The following table (Table 2.1) contains the Annual National Assessment numeracy results of all nine provinces for 2014. The results of the Eastern Cape and the Free State grades 1-6 are highlighted to show the difference between these two provinces. The Vassiliou Mathematics Proficiency Test (VASSI), the subject of this research, has a standardisation sample grade 1-6 learners from the Free State area only but can be used all over South Africa (Vassiliou, 2000).

Table 2.1

Data from the Report on the Annual National Assessment of 2014 (Department of Basic Education, 2014)

Province	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
EC	64.5%	57.7%	52.2%	34.8%	32.2%	36.8%
FS	71.1%	63.7%	58.5%	37.3%	39.3%	47.7%
GP	73.9%	66.1%	60.7%	44.4%	45.7%	51.1%
KZN	69.3%	63.9%	59.1%	39.5%	37.6%	43.8%
LP	62.8%	57.2%	46.8%	28.4%	27.9%	35.3%
MP	67.4%	62.6%	52.5%	35.5%	36.1%	39.9%
NC	65.9%	58.8%	53.3%	34.5%	34.0%	39.3%
NW	64.4%	58.2%	49.3%	30.8%	32.5%	38.8%
WC	71.9%	63.0%	60.5%	41.9%	45.2%	50.9%
Difference between EC and FS	**6.6%**	**6%**	**6.3%**	**2.5%**	**7.1%**	**10.9%**

Table 2.1 shows that the Eastern Cape grade 1 learners ranked third last out of the nine provinces. Grade 2 learners ranked second last, the Grade 3 learners third last, Grade 4 learners fourth last, Grade 5 learners second last and the Grade 6 learners second last. Furthermore, when it comes to numeracy, the pupils from the Free State (the standardisation sample of the VASSI) outperformed those of the Eastern Cape in 2014 by 6.6%, 6%, 6.3%, 2.5%, 7.1% and 10.9% for each grade respectively. Thus indicating a possible need for a different set of norms for the learners of the Eastern Cape.

This then leads to the various cognitive factors which form barriers against learning and achievement in mathematics.

2.4 COGNITIVE BARRIERS TO LEARNING MATHEMATICS

2.4.1 Introduction. The above section has briefly outlined some socio-cultural as well as quality of education barriers, that have been identified as negatively affecting leaner's ability to learn and achieve in the field of mathematics. Beside the above, other factors such as neuropsychological variables have been identified. Briefly outlined below are some neuropsychological factors that have been noted as having an effect on numeracy and mathematics education.

Research into mathematics and neuropsychology has often looked into cognitive cognates such as (i) memory, (ii) processing speed, (iii) executive functioning, and (iv) attention and the effect that these constructs have on mathematics learning and mathematical difficulties (Bull & Johnston, 1997; Rasmussen, Mcauley & Andrew, 2007). For the sake of brevity, I will briefly expand on the influence of memory, processing speed and executive functioning on mathematical learning.

2.4.2 Working Memory and Mathematics. Bull and Johnston (1997) in their study of mathematical difficulties in children, found that children who are "low achievers" in mathematics tend to have a poor working memory, resulting in poor or incomplete representations of numbers and facts. Bull and Scerif (2001) found that children of low mathematical ability struggle to hold information in their long term memory but that once they have learned a strategy they are able to maintain it. However these children experience difficulty when this learned strategy must be inhibited and a new one adopted (Bull & Scerif, 2001). In the same study it was found that there is a positive relationship between counting span and achievement in mathematics, with children who are said to be high achievers in mathematics having a higher counting span. According to the authors counting span is dependent on the ability to hold information in the working memory whilst at the same time inhibiting old information.

A Brazilian study by Engel, Santos and Gathercole (2008) looking at the impact socioeconomic factors may have on children's performance on working memory and vocabulary tests found that there was no significant difference between children of low socioeconomic background and those of a high socio economic background when it came to working memory. However, there was a difference on receptive and expressive vocabulary (Engel, Santos, & Gathercole, 2008). Other studies (D'Angiulli, Herdman, Stapells, & Hertzman, 2008; Farah et al., 2006) show that low SES has a negative impact on working memory including other executive function constructs such as inhibitory control, attention processes, planning and self-regulation etc.

2.4.3 Processing Speed and Mathematics. Bull and Johnston (1997) in the same study, found that low-ability mathematicians had slower processing speed compared to high ability mathematics counterparts. Processing speed in this study was defined as the highest rate cognitive operations can be executed in and was measured using the Visual Number Matching and Cross-out tasks based on the Woodcock-Johnson tests of Cognitive Ability. The low achieving mathematicians in the same study also relied on inefficient counting strategies instead of using direct memory retrieval of numbers like their high-mathematics achieving counterparts. These children were slow at identifying items and this slowness was linked to possibly not being familiar with and being inexperienced in mathematics.

2.4.4 Executive Functioning and Mathematics. Executive functioning, which involves a cohort of constructs that involve planning; selective attention, inhibition and working memory (Rasmussen & Bisanz, 2009; Rasmussen, Mcauley & Andrew, 2007) has been implicated in mathematics learning. Bull and Scerif (2001) in their study of children's mathematical skills found that mathematical ability correlated with executive functioning, in particular inhibition and working memory. Children who struggled with inhibition were found to struggle with inhibiting unnecessary or irrelevant information from entering their working memory thus affecting the child's mathematical performance (Bull & Scerif, 2001; Rasmussen et al., 2007). With regard to working memory, Geary (1993) identified two categories with different developmental trajectories; (a) developmentally immature mathematics procedures such as deficits in counting and working memory, and (b) difficulties with the encoding and retrieval of mathematic facts from long-term memory. With regard to the first construct, Geary (1993) found that children with a slow counting speed or with a short memory span for numbers made more computational errors than those without, these children also run the risk of failure to represent basic facts in their long term memory. With regard to the second, it was found that these children tend to associate a problem with an answer, however if a computational error is made then the problem is associated with the incorrect answer, and when faced with the same problem the child then retrieves that same incorrect answer. Both of these categories are linked to and thus highlight the importance of the working memory, this could be because deficits in this area may lead to difficulties in developing long-term memory representations of mathematical facts (Geary, 1993). The findings from Geary (1993) are similar to those by Mc Lean and Hitch (1999) who found that children who are “low achievers” in mathematics are “impaired in several, but not all, aspects of working memory”. A key finding in Mc Lean and Hitch’s (1999) research is that for some children information in the working memory is lost before pertinent associations are made, this is a result of a failure to develop “long-term memory for basic number facts”. This finding is in agreement with Geary (1993) who states that the amount of numerals that one can hold in the working memory is linked to how fast one can count. A slow counting speed often results in information in the working memory decaying or lost before the child can solve the mathematical problem (Geary, 1993; McLean & Hitch, 1999). Other findings in the same research was that spatiotemporal working memory as well as other executive processes are poor (McLean & Hitch, 1999).

Executive functioning has been negatively linked to socioeconomic status in numerous studies (Hermida et al., 2015; Lipina & Posner, 2012). For example, Hackman and Farah (2009) reviewed studies which concluded that language and executive functioning are negatively affected by a low SES. Since executive functioning has been linked to children’s learning of and achievement in mathematics, one can conclude that children of low SES such as the sample of my study may perform poorly in mathematics.

2.5 THE LEARNER AND THE TEACHER AS BARRIERS TO LEARNING

2.5.1 Introduction. The following section is concerned with how learners and teachers can form part of the barriers in learning. Children's developmental stages as stipulated by Piaget are discussed followed by the learner's gender, language, attitude and mood. A section on teachers also follows, this section briefly outlines the teacher's knowledge of the subject of mathematics and their training therein, it also looks at the attitude and mood of the teacher.

2.5.2 The learner. According to Vassiliou (2000, p.20) mathematics is "a powerful example of the functioning of human intelligence" it is also a tool that enhances intelligence. In order for children to succeed in mathematics certain developmental stages need to be reached, namely cognitive, personal and social development. For the sake of brevity only the cognitive development will be further explored.

2.5.2.1 Piaget's Theory of Cognitive Development. Piaget's theory of cognitive development has provided insight into how children learn mathematics (Lovell, 1972; Ojose, 2008). Children continually go through stages of development, this development is a result of the transformation of thought processes in children (Ojose, 2008). Although in these stages children are grouped by age, each child develops differently from another (Ojose, 2008). According to Vassiliou (2000) there are three principles in Piaget's theory, the genetic/ biological, maturational and hierarchical. These principles affect the way mathematical processing is viewed. According to the genetic/biological principle higher order processes much like that of mathematics stem from biological mechanisms which are dependent on one's nervous system (Vassiliou, 2000). The maturational system states that concept formation comes in stages which emerge in certain age ranges. The hierarchical principle states that a child has to go through each stage before moving on to subsequent stages (Ojose, 2008; Vassiliou, 2000).

Piaget identified four stages: sensorimotor, preoperational, concrete operational and the formal stage (Ojose, 2008; Piaget 1969 as cited by Vassiliou, 2000). These staged will be explored individually and linked to mathematics.

a) The sensorimotor stage.

   This stage starts from birth and ends at age 2 years (Vassiliou, 2000). In this stage a child develops object permanence as well as the ability to connect numbers and objects (Ojose, 2008).

b) The preoperational stage.

   This staged which lasts from age 2-7 years, is marked with an increase in language and the development of symbolic thought, egocentrism and limited logic (Ojose, 2008; Vassiliou, 2003). Children struggle with reversal operations, for example, they may know that 3+2=5 but may not know that 5-2=3 (Ojose, 2008; Vassiliou, 2000). This, coupled with a limited logic, assimilation and accommodation hinders the child from “making a coherent whole out of the explanation” (Vassiliou, 2000, p.45.).

c) The concrete operational stage.

   The concrete operational stage lasts from age 7-12/13 years (Vassiliou, 2003). At this stage there is a remarkable increase in cognition, language and basic skills (Ojose, 2008; Vassiliou, 2000). Seriation (ordering objects in decreasing or increasing length, weight and volume) and classification (grouping objects according to similarities) also develop at this stage (Lovell, 1972; Ojose, 2008; Vassiliou, 2003). Children develop the conservation principle which the ability of knowing that certain properties of objects remain the same despite changes made to them (Ojose, 2008; Vassiliou, 2003). Ojose (2008) makes the example of the liquid experiment where the child knows that although the level of the liquid is lower it is still the same amount of liquid, the lowered level was due to the wider circumference of the second container. According to Vassiliou (2008) at this stage, children develop decentered (using various aspects in solving math problems) and reversible (being able to understand reversal operations) thought. Decentered and reversible thought are fundamental in understanding mathematical concepts as well as in the ability of conservation, classification and ordering (Vassiliou, 2003). Primary school mathematics is highly dependent on the mental operations acquired in this stage, failure of this development renders the child as unable to move on to advanced levels in mathematics (Vassiliou, 2000).

d) The formal operational stage.

This stage which is marked with more scientific and abstract thought, starts at age 12/13 years (Vassiliou, 2003). According to Ojose (2008) abstract thought allows the child to be able to solve math problems using symbols only without needing a concrete explanation. The child is able to think hypothetically, form hypotheses and deduce possibilities (Ojose, 2008; Vassiliou, 2003). Reasoning skills developed at this stage include: 1) clarification- the ability to analyse a problem statement and extract the necessary information to solve the problem, 2) inference- this involves inductive (moving from specifics to making generalisations) and deductive (moving from generalisations to specifics) reasoning, 3) evaluation- using a predetermined criterion to judge whether the solution to the problem is correct or not, 4) application- applying what is learned in mathematics to real life (Ojose, 2008).

Piaget also made the distinction between three kinds of knowledge, namely, physical knowledge, social-conventional knowledge and logico-mathematical knowledge (Kamii, Rummelsburg, & Kari, 2005). Many Grade 1 learners from low SES backgrounds start school without logico-mathematical knowledge (Kamii et al., 2005). These low-performing and low SES children's logico-mathematical knowledge is equated to that of middle class three-four year olds (Kamii et al., 2005). According to Kamii et al., (2005) unlike physical knowledge which is knowing that a ball rolls and bounces and social-conventional knowledge which is words e.g. one, two, three, Piaget's logico-mathematical knowledge refers to the mental relationship which exists in a child's mind. An example of this knowledge is the ability for children to count items and when some are hidden they are able to state the number of items hidden (Kamii et al., 2005). In such a situation Grade 1 learners from low SES homes struggle to give the correct response (Kamii et al., 2005). When logico-mathematical knowledge is in place, a learner is able to pick up two sticks, one red, the other blue, and although different because of their colours, know that they are similar because of their shape and length (Kamii et al., 2005). This child can make another mental relationship between the sticks by stating their number, two (Kamii et al., 2005). From this, children can form higher-order relationships such as $(2 + 2 = 4)$ and even more complicated ones like $(2 \times 2 = 4)$ (Kamii et al., 2005). Within logico-mathematical knowledge, logico-arithmatical knowledge and spatio-temporal knowledge are found (Kamii et al., 2005). Logico-arithmatical knowledge consists of classification, seriation and number- constructs which develop in the concrete operational stage (Kamii et al., 2005). Majority of the learners sampled for my research are in the concrete operational stage found in ages 7 to 12/13.

From the above, one can deduce that a learner’s developmental stage has an impact on what they can learn. There is also an implication on what can be taught to a child and how it can be taught. Teaching a certain concept to a learner before they are cognitively or developmentally ready will not add to the child’s development (Vassiliou, 2003). Vassiliou (2003) and Ojose (2008) state that there have been many critiques of Piaget’s theory, these come from theorists known as the neo-Piagetians. They state that Piaget’s theory underestimates young children and overestimates the older ones. Some believe that there are many factors which need to be considered when evaluating a child’s development, these entail language, formal education, familiarity with the tasks the child is requested to complete, perception and real life knowledge. These are not accounted for in Piaget’s theory.

2.5.2.2 Gender, language, attitude and mood. According to Esterhuyse and Beukes (as cited by Vassiliou 2000) there is a positive and high correlation between language and math performance. On a similar note Cuevas (1984) states that a good understanding of the meaning of mathematical terms is needed in order to fully grasp mathematical concepts and without this the individual will perform poorly on mathematics assessments. The role language plays in mathematics assessment is crucial, more so when assessing a learner’s proficiency in mathematics (Cuevas, 1984). The Vassiliou Math Proficiency Test is available in English, in accordance with the above information a process of translating the test from English to isiXhosa was undertaken (further explained in the methods chapter).

According to Kiptum, Rono, Too, Bii and Too (2013) there have been various studies on demographics which affect mathematics performance, however, gender is most frequently studied. Various studies reveal that males tend to do better on mathematics tests that involve problem-solving and females tend to do better in computation (Hyde, Fennema & Lamon, 1990; Mussen, Conger, Kagan & Huston, 1990). Hyde, Fennema and Lamon (1990) continue to state that there is no significant gender difference in the understanding of mathematics concepts. A different study shows that females tend to outperform males in mathematics (Kimball, 1989). More recent studies, however, have revealed that gender differences in mathematics are decreasing (Kiptum et al., 2013). Other studies indicate that males and females perform equally well in mathematics, however, there are gender differences in favor of the males in higher grades (Mullis, Martin, Fierros, Goldberg, & Stemler, 2000; Mussen, Conger, Kagan & Huston, 1990.

According to Vassiliou (2000) attitude, mood and confidence can influence a learner's performance. The author continues and states that if learners are not in the mood to learn or are tired their results will not be a true reflection of their capabilities as their work will have careless mistakes.

2.5.3 Teachers as a Barrier to Learning. As mentioned above access to education does not necessarily translate to obtaining a quality education. One of the most important factors which adds to quality of education is the teacher and teaching itself. The following section looks at teacher training in mathematics, teacher attitude and teacher quality.

2.5.3.1 Teachers and Mathematics. Cueto and colleagues, in their study of pedagogical content knowledge (PCK) found that learners with higher scores in school were more likely to have a teacher with higher PCK levels (Cueto, León, Sorto, & Miranda, 2016). They also found a positive correlation between PCK and socioeconomic status: learners with a higher socioeconomic status had teachers who scored high on the PCK. These findings are similar to those by Moller and colleagues who found that in schools where teachers felt a sense of professional communities and teacher collaboration higher mathematics scores were achieved (Moller, Mickelson, Stearns, Banerjee, & Bottia, 2013).

Diminished achievement gaps by race and socioeconomic status were also found in these schools (Moller et al., 2013).

In South Africa, according to Bernstein (2014) only 32% of grade 6 math teachers have sufficient knowledge in mathematics and this has been attributed to the insufficient training that many teachers are said to receive (Bernstein, 2014). In her paper, Howie (1997) states that many trainee math and science teachers have chosen this course as a second or third option, as many were not chosen for their first choices. This results in teachers who are not very much motivated to teach the subject (Howie, 1997). According to Vassiliou (2000), in mathematics, unlike in the social sciences and languages, the child’s learning is directly dependent on the teacher’s knowledge of the subject. If the teacher does not have the necessary proficiency and expertise they will not show the necessary interest and enthusiasm needed in delivering the lesson neither will they be able to anticipate any learning problems which may arise (Kapp as cited by Vassiliou, 2000). Cockburn (2005) states that teachers with too little knowledge are able to teach the basics to the learners, however, when the learners need more abstract information the teacher is unable to do so. The author also states that teachers with too much knowledge quickly explain concepts to learners expecting them to grasp it before they actually do, they also overload the learner with too much intellectual information. Bernstein (2014) state that there is poor utilization of teachers specifically within mathematics. Teachers qualified to and who want to teach the subject are often found teaching other subjects (Bernstein, 2014). In a study done by Carnoy and Chisholm (2008) in the Gauteng Province they found that teachers who were not qualified, through training, to teach certain subjects were appointed to teach this subject. Mathematics had three times more teachers teaching the subject than those who were actually trained to teach it (Carnoy & Chisholm, 2008).

2.5.3.2 Teacher attitude and mood. Insufficient teacher training and knowledge, although playing a major role, is not the only determining factor of learner achievement, the attitude and mood of the teacher also needs to be considered. Bradley and Crowyn (2002) state that teachers pay more negative attention to poor children as they tend to see these children as fulfilling the stereotypes which they (teachers) hold. The frustrations that arise due to this negative interaction coupled with school failure then cause the learners to act out which in turn reinforces the teachers' beliefs (Bradley & Crowyn, 2002; Cockburn, 2005). Cockburn (2005) in agreement with Bradley and Crowyn (2002) states that if a teacher dislikes a subject this affects the learner's own attitude towards the subject, moreover, if a teacher negatively labels a child this affects this child's performance. If teachers are in a bad mood the learner will be afraid to ask questions, whatever concept is taught that day will not be learned by the learner (Cockburn, 2005).

In 2002, five percent (5%) of learners complained about the quality of teaching and seven percent (7%) complained about lack of teachers in the Eastern Cape (Statistics South Africa, 2013). In 2005 the numbers rose: six point five percent (6.5%) of learners complained about poor teaching and nine point five percent (9.5%) complained about a lack of teachers (Statistics South Africa, 2013). The numbers have since dropped, as in 2011 the complaints were from one percent (1%) and one point three percent (1.3%) respectively (Statistics South Africa, 2013). More germane to this research, in a study done by Lemon (2004) which included Grahamstown schools, it was found that a number of challenges experienced by 'township schools' have translated into barriers to teaching and learning. Some of these barriers included the (a) poor quality of teaching and (b) demotivation and lack of commitment by teachers (Lemon, 2004). The implication of this finding is that teachers feel demoralized and demotivated, which in turn affects their motivation when teaching.

Insufficient math knowledge and demotivation in teachers leads to low confidence and a lack of inspiration within the classroom context, this negatively affects the learning process of the pupils (Howie, 1997). The dire mathematical situation in South African schools has been painted, the question is now on how to remedy the situation.

2.6 PSYCHOMETRIC TEST STANDARDISATION AND NORMING

2.6.1 Introduction. The above section has dealt predominantly with the various barriers which negatively affect learners' performance in mathematics. The difference in quality of education between model C schools and those in the townships was also highlighted. With both these in place a section on the fair and appropriate use of psychometric assessments in the South African context follows.

South Africa is a multilingual and multicultural society in which the use of psychological assessments to establish cognitive functioning levels, is a well-known practice (Knoetze, Bass, & Steele, 2005). In line with this, the vast differences in schooling systems, variations in the quality of education, and differing socio-economic levels render the need for psychological assessments that are be fair and representative in their nature (Foxcroft, 1997; Shuttleworth-Edwards, 2016).

The above statement leads to the brief exposition of what constitutes norms and standardisation.

2.6.2 Norms. Norms are defined as the calculated average performance or average score of a group or standardisation sample (Ardila, 1995; Cicchetti, 1994). Ardila (1995) further explains that this calculated average performance is used in assessing abnormalities in a given population as well as assessing where one lies in relation to the rest of the group. Norms also allow for comparisons between groups or populations and form part of the fair use of psychometric tests (Ardila, 1995). Psychometric tests are interpreted according to the norms developed within and for that specific context (Foxcroft, 2011). Foxcroft (2011) states that tests which are developed for use in multicultural contexts like that of Africa should include constructs which are universal to all cultures within that context. Furthermore, testing is a westernised activity which is unfamiliar to the non-westernised cultures and one which is not always "transportable" between these two cultures (Foxcroft, 2011). In order for the use of assessments to be fair and culturally sound major revision, adaptation and norm development as well as test development needs to occur (Foxcroft, Paterson, Le Roux, & Herbst, 2004; Hambleton, 1994). Tests developed in western countries are still predominantly used in South Africa, these tests cannot be applied to this context without adaptation and re-norming (Foxcroft, 2011). In line with this, Foxcroft (2011, p.8) states:

> *"It is essential that we start raising consciousness among assessment practitioners regarding how unacceptable (unethical) it is to use Westernized tests without adapting and re-norming them, and establishing 'local' psychometric properties".*

As previously mentioned, the practice of population based norms in a multicultural country like South Africa has been deemed "obsolete" (Shuttleworth-Edwards, 2016, p.2). Shuttleworth-Edwards makes an example of the Weschler Adult Intelligence Scale- Fourth

Edition (WAIS-IV) which was launched for use in the country. The norming process of the WAIS- IV included adaptation on the population of South Africa (Shuttleworth-Edwards, 2016). The risk in such norms is that clinicians may assume that the test is appropriate for the South African context which could lead to erroneous interpretations and diagnoses (Shuttleworth-edwards, 2016). In such contexts demographically focused norms like that of Shuttleworth-Edwards and colleagues would be more appropriate (Shuttleworth-Edwards, 2016). Foxcroft (2011) highlights samples that do not exhibit the proper demographics of a country as one of the limitations of psychometric test norming. However, if tests are normed locally using a wide sample, more accurate interpretation is achieved. To sum up the main argument of this research: without appropriate standardization it is difficult to develop norms which are used for the valid interpretation of results on psychometric tests of any description (Cicchetti, 1994; Vassiliou, 2000).

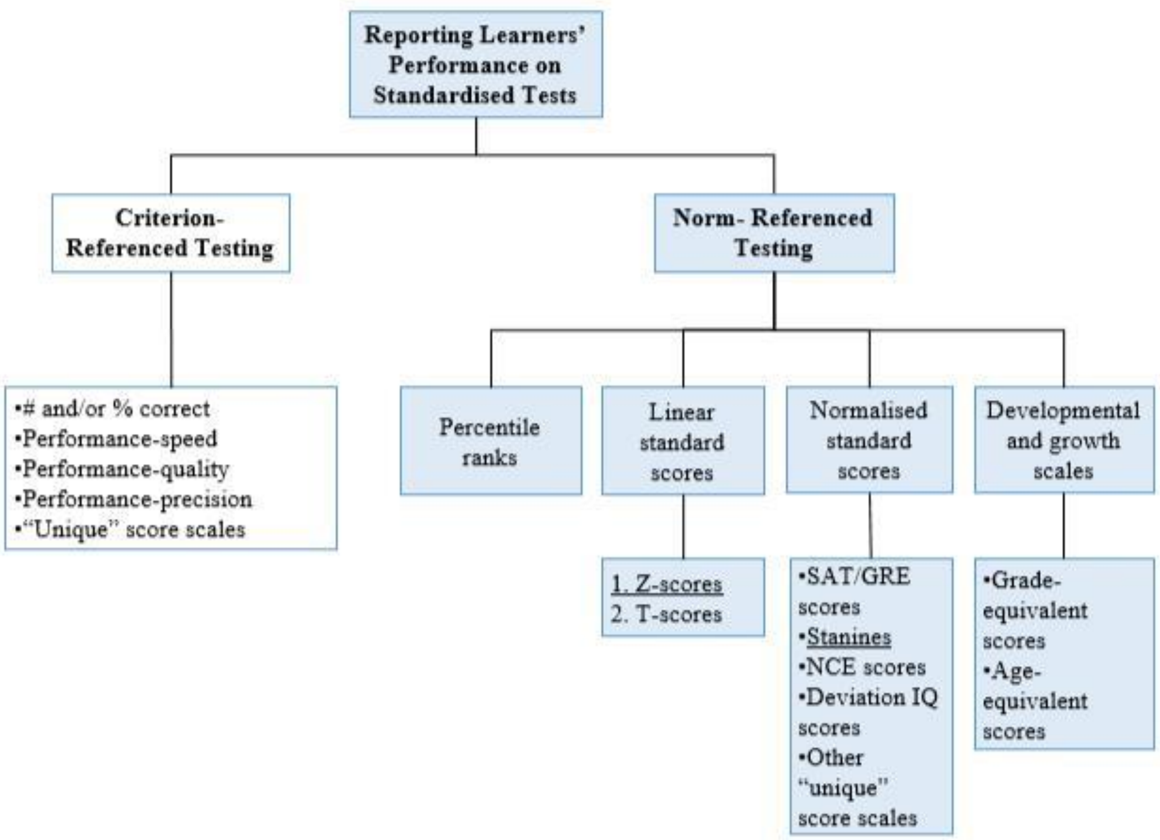
2.6.3 Standardisation. Standardisation is a process which includes converting raw scores into a number of derived scores such as standard scores, percentile rankings, z scores, t scores and IQ scores (Cicchetti, 1994; Robinson Kurpius & Stafford, 2006). When standardising one needs to take into consideration a number of variables such as gender, age, socio economic status, education, geographic location, etc. (Cicchetti, 1994). Nell (1999), in support of Cicchetti, states that demographics such as age and education have a great bearing on psychometric test performance. Nell (1999) further concurs that factors such as environmental variables (socio-economic status, urbanisation etc.) as well as home language also play an integral role in test performance and scores (Nell, 1999).

Standardisation allows for comparison between different groups of people as well as comparison of scores on different tests (Robinson Kurpius & Stafford, 2006). There are statistical properties which are also included in the process of standardizing assessments, these include: the sample size, the means and standard deviations of each test score, and the number of items in the assessment (Vassiliou, 2003). There are two main goals in the process of standardisation: 1) through the use of an appropriate sample, obtain information on the test scores of the population and 2) to obtain principles which can be used to convert the test scores into data with a normal distribution (Rust & Golombok, 1999). Proper standardisation facilitates the creation of appropriate norms which in turn allow for valid interpretations (Cicchetti, 1994).

2.6.4 Types of Norms. Figure 1 below contains a summary on the different types of norms.

Figure 2.1

Summary of Methods of Reporting Scores on Standardised Tests (Mertler, 2007)



There are two ways in which scores can be reported, namely, *criterion-referenced* and *norm-referenced* types or norms.

2.6.4.1 Criterion-Referenced Norm Tests. Criterion-referenced norm tests are those that test one's proficiency on a given criterion (Robinson Kurpius & Stafford, 2006). They allow one to draw conclusions about the learner's performance relative to a large domain of content (Mertler, 2007). Statistical analysis of the learner's score is not needed here in order to make interpretations (Mertler, 2007). This makes it difficult for the individual learner's score to be compared to those of other learners (Mertler, 2007). According to Mertler (2007), this kind of testing is needed when one wants to know how much content the learner has mastered.

2.6.4.2 Norm-Referenced Tests. According to Robinson Kurpius and

Stafford (2006), norm-referenced tests are those where scores are distributed in a bell-shaped curve and thus interpreted according to this bell-shaped curve. Here, unlike in criterion- referenced testing, the learner's score is comparable to those of others within their norm-referenced group (Mertler, 2007). These scores are statistically analysed and thus provide information on how the learner compares to others in their norm group (Mertler, 2007).

The main difference between these two tests is that in criterion- referenced testing the individual learner‘s score is not dependent on the performance of other students, however, in norm-referenced testing, it is (Mertler, 2007). There are various types of norm-referenced scores are usually converted into some other scale through mathematical transformation (Mertler, 2007). As shown in the above diagram, the four norm-referenced forms of reporting learner scores will be explored:

a) Percentiles.

Percentiles, also referred to as percentile ranks, show the percentage of the norm group learners who scored below a specific raw score (Mertler, 2007; Robinson Kurpius & Stafford, 2006; Strauss, et al., 2006). Mertler (2007) stresses the importance of not equating percentile rank to percentages, percentile ranks simply show the percentage of people which one has outperformed. Percentile ranks were one of the methods of reporting learner scores which was adopted in this research.

b) Linear standard scores.

Linear standard scores, often reported in standard deviations, are those which show how far a learner's raw score is from the group mean. Although there are two kinds of linear standard scores (z-scores and T-scores) only the z-scores were used in this research project. Robinson Kurpius and Stafford (2006) describe z-scores as the foundational standard score. They are on a continuum with over 99% of scores ranging from -3.00 to +3.00. The sign in front of the z-score indicates whether the raw score is below (-) or above (+) the mean and the value determines how many standard deviations it is from the mean (Mertler, 2007; Robinson Kurpius & Stafford, 2006). Robinson Kurpius and Stafford (2006) state that z-scores range from -4.00 to +4.00 and are presented with two decimal points. The following is the formula for calculating a z-score:

$$= \; -$$

The mean (*M*) of the set of scores is subtracted from the learner's raw score (*X*), the answer is then divided by the standard deviation (SD) of the set of scores (Mertler, 2007; Robinson Kurpius & Stafford, 2006; Rust & Golombok, 1999; Strauss et al, 2006).

T-scores have a mean of 50 and a standard deviation of 10 and are calculated by multiplying the z -score by 10 (standard deviation) then adding 50 (mean) (Mertler, 2007; Robinson Kurpius & Stafford, 2006; Rust & Golombok, 1999).

c) Normalised standard scores.

Normalising standard scores involves transforming the shape of a distribution of raw scores to fit the normal distribution of a bell-shaped curve, this is done so that different types of standard scores can be developed (Mertler, 2007). Figure 1 shows various types of normalised standard scores. Of interest to my analysis, are *Stanines*, which were used for my research analysis.

1. SAT/GRE Scores- Scholastic Assessment Test and Graduate Record Examination have a scale with a mean of 500 and standard deviation of 100, low scores on these are 200, and high scores are 800. These scores can be derived from the z-score by simply multiplying the z-score by 100 then adding the answer to 500 (Mertler, 2007).

2. Stanines arrange scores into a scale ranging from 1 (extreme low end) to 9 (extreme high-end), with a mean of 5 and a standard deviation of 2 (Mertler, 2007; Rust & Golombok, 1999). Stanines provide intervals wherein each learner within that interval is assigned a stanine number corresponding to it (Mertler, 2007. Mertler (2007) further states that there is a relationship between percentile ranks and stanines and makes an example of percentile rank between 40-59 falls on stanine 5, a percentile rank between 60-76 falls on the 6th stanine. This relationship can be seen on figure...below. Stanines are advantageous because they give the range within which a learner's performance is in instead of a precise estimate (Merlter, 2007). Calculating a stanine involves multiplying a z-score by two then adding 5.

Due to a large number of learners as well as to avoid errors Excel was used to calculate the stanines for this research project.

3. NCE scores- Normal Curve Equivalent scores, unlike percentile ranks, have equal units throughout their continuum which range from 1-99, and have a mean equal to 50 and a standard deviation equal to 21.06 (Mertler, 2007). They can be calculated by multiplying the z-score by 21.06 and adding the result to 50 (Mertler, 2007).

4. Deviation IQ Scores- these standard scores are usually found when assessing mental ability (Mertler, 2007). They operate on a normal distribution with a mean of 100 and a standard deviation of 15 or 16. Calculating a deviation IQ on a test with a standard deviation of 15 involves multiplying the z-score by 15 and adding 100 (Mertler, 2007).

5. Other “unique“ score scales- According to Mertler (2007) some tests have their own standard scale scores, these are usually published in the manual of the test.

d) Developmental and growth scales.

Developmental and growth scales aim to identify a leaner’s growth in various levels such as age and grade by comparing the learner’s performance to some reference groups (Mertler, 2007). These kinds of scores are useful in monitoring the mental and reading ability as well as other forms of development and growth (Mertler, 2007). There are two kinds of these scales, namely the Grade-Equivalent Score and the Age-Equivalent Scores.

1. Grade-Equivalent Scores- the grade-equivalent of a raw score on any test shows the grade level at which the learner earns this raw score (Mertler, 2007). The grade-equivalent are presented in the form of two numerical values divided by a period,

where the first number indicates the grade and the second the month of that school year (Mertler, 2007). To make this clearer Mertler (2007) provides this example: if a student receives a grade-equivalent score of 4.2, this would mean that the learner’s performance is equal to a learner who took the same test in the second month of grade four.

2. Age-Equivalent Score- these scores are much like the grade-equivalent scores, they are based on the average performance of a learner at different age levels (Mertler, 2007).

2.6.5 Psychometric Tests and Norming in South Africa. There are a number of existing psychometric tests which have been standardised for the South African context (Foxcroft, 1997). These include tests like the Ravens Coloured Progressive Matrices by Knoetze, Bass and Steele (2005) normed for the isiXhosa speaking primary school learners of the Eastern Cape, the Weschler Intelligence Scale for Children (WISC-IV) (Shuttleworth-Edwards, van der Merwe, van Tonder & Radloff, 2013) normed for Grade 7 English and isiXhosa speaking children, the Weschler Memory Scale Associated Learning and Visual Reproduction Subtests by Fike, Knoetze, Shuttleworth-Edwards and Radloff (2012) normed for isiXhosa speaking unskilled workers, just to name a few.

In spite of the above, it is worth noting that not only is the South African context multilingual and multicultural it is also increasingly becoming acultural and westernized. It is therefore important that such international tests not be thrown out but instead a constant revision of the culturally biased aspects as well as the development of norms be done (International Tests Commission, 2005; Shuttleworth-Jordan, 1996). Hambleton and Kanjee (1995) list three main reasons in favour of psychometric test adaptation. Firstly, fairness is increased, more so when the adaptation results in the testee being assessed in their preferred language. Secondly, it allows for comparative studies on a national, cross-cultural and an international level. International level comparative studies include the afore mentioned TIMMS which needed to be properly adapted, adequately applied and fairly interpreted for multiple contexts and cultures before testing commenced (Hambleton, 1994). Without this the results of these international and other national comparative tests can be deemed as invalid and unreliable (Hambleton,1994). Lastly, adaptation is much more cost effective than producing a new test. Hambleton and Kanjee (1995) further state that psychometric tests are at times adapted so that the existing norms which come with that test can be used, however this largely depends on whether those norms are relevant to the testee. Already existing psychometric tests are trusted and respected by their users, such tests also come with copyright restrictions which prohibit the production of tests which may be similar to them (Hambleton & Kanjee, 1995).

It is these tests that can be used for the more westernised and aculturised South Africans (Foxcroft, 1997; Shuttleworth-Jordan, 1996).

2.7 CONCLUSION

Upholding the *"fairness and equality"* of the constitution requires the expansion of the VASSI norms to include a sample from the Eastern Cape. The ANA results of 2013 and 2014 show that when it comes to mathematics the Eastern Cape lags behind the Free State across all grades (Department of Basic Education, 2014). In addition to this, norming requires that samples include the various demographics such as age, language, gender, education and more applicable to this research, geographical location which are found in the population for which the test is intended to be used on.

The poor quality of education which is said to be found in disadvantaged schools emanates for the previous oppressive system which encouraged differences in education for each racial group. Despite the many laws enforced to ensure equal education for all, although the racial segregation in schools and inferior curricula were abolished, the situation in the township schools remains the same. Previously model C schools still outperform township schools. Township schools are still without the necessary resources that learners need to learn and perform well in their studies. This lack of resources put together with low socioeconomic status of learners, poor quality of teaching, poor teacher mathematical knowledge and attitude and other learner cognitive factors have been listed as the leading barriers in the learners' achievement in mathematics. To add to this are cognitive barriers like executive functioning and memory etc. which were also linked to socioeconomic status.

The ongoing debate on whether westernised tests should be used in the African, non-westernised society or whether indigenous tests should be used exclusively is well-known amongst testing scholars and the consensus seems to be that western tests should be adapted for Africa, nevertheless indigenous ones need to be created (Foxcroft, 2011). This is to ensure there is a wider variety of valid and reliable psychometric tests (Foxcroft, 2011). Ardila (2005) lists a number of recommendations these include scrutinising tests for culture bias, developing tests which are appropriate to the cultural context and creating different norms for different cultural groups. As alluded to there is a vast difference between "model C" learners' school performance and that of learners in township schools. There is also a difference between learners of the Eastern Cape and those in the Free State region. This difference is mainly due to the differing qualities of education learners receive in these schools. In order to compare these two groups on any given test the playing ground needs to be leveled through adaptation, norming and development of more relevant psychometric tests.

Adding on the above, the racial disadvantage of the past has now become a one of class, however, this class disadvantage is largely along racial divide. The implications of this are that the status quo of South Africa is likely to be maintained. The poor will remain poor and more germane to this study is that the students in disadvantaged schools are more likely to perform poorer than those in the affluent schools when it comes to psychological assessments. This is the case in school subjects as shown by Bernstein (2014). In her paper which looks at international studies black learners' literacy scores are less than two-thirds of those of white learners and their numeracy scores are less than half of those of white leaners (Bernstein, 2014). Hoadley (2007) argues that it is schools that produce this social class divide due to the different processes employed in the classrooms. This worsens the differences between learners placing the working class learners at a disadvantage.

In order for the VASSI norms to be fairly applied to the vast majority of children of the Eastern Cape the norms need to include these children as part of their standardisation sample.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

The research method used in this research study is largely descriptive in nature. The main findings are meant to constitute a set of local normative data of the VASSI for the target population under study. In the subsequent sections, I detail how I went about achieving my research objectives. The section concludes by covering the ethical consideration I had to undertake to achieve my research goals.

3.2 RESEARCH OBJECTIVES

The main objective of my research was to generate preliminary norms for grade one to six learners on the VASSI. More specifically, the researcher sought to focus on generating norms for learners attending disadvantaged ‘township’ schools in Grahamstown, Eastern Cape. This study sought to generate norms according to the geographical location of the participants, rather than the participants’ ethnic heritage.

3.3 RESEARCH DESIGN AND SETTING

The study employed a quantitative research design. This design according to Bryman (2012), aims to conceptualise and understand social reality so as to generalise findings of the sample onto the population, in this case, Grahamstown, Eastern Cape (Bryman, 2012). It is important to note that data collection for this study spanned over a period of two years, from mid-2014 to mid-2016. Forming part of this study is archival data from three schools consisting of 169 learners, which was collected in the 2014 academic year by former Rhodes University Honours students. During the 2016 academic calendar of my Masters studies, I further collected data from one extra school (further referred to as School A), a total of 555 learners. In sum, all four schools were public ‘township’ government schools located in Joza Township, Grahamstown, Eastern Cape. All researchers were trained by Mr Jan Knoetze (supervisor).

3.4 PARTICIPANTS

There was a two-tiered process in the recruitment of participants: *First*, purposive sampling was used to select schools to participate in the study. The inclusion criterion here was middle performing schools as identified by the subject advisor[7] of the Makana region, under which Grahamstown falls. The reason for selecting middle performing schools was not to skew the data to either end. *Secondly*, from this pool, four schools were conveniently, (because of availability) selected to participate in the study. The 2014 Honours students collected data from three of the identified schools (169 learners), whereas, I collected data from one of the suggested schools, school A (555 learners). The final sample size comprised of 724 isiXhosa speaking learners from the above-identified schools. Of the sample, 355 were females, and 369 were males. There was a total of 147 grade 1s, 123 grade 2s, 117 grade 3s, 128 grade 4s, 113 grade 5s and 96 grade 6s. The average age for grades 1-6 were 6.72; 7.66; 8.86; 10.10; 10.97 and 12.31 respectively (Please see Table 3.1 for a summary of the above).

[7] A meeting was set up between my supervisor and the subject advisor from the Department of Education who helped identify the township schools of interest.

Table 3.1

Participant Information

Grade	Total Number of Participants	Total Number of Females	Total Number of Males	Average Age	Standard Deviation of Age
1	147	64	83	6.72	0.89
2	123	68	55	7.66	0.86
3	117	61	56	8.86	0.74
4	128	62	66	10.10	0.96
5	113	53	60	10.97	1.03
6	96	47	49	12.31	1.01

3.4.1 Inclusion and Exclusion criteria.

There were two sets of inclusion/exclusion criteria used for my data collection. One, for selecting the school, the other for the selection of participants. The inclusion criteria for schools was as mentioned above, middle performing schools in the ANA as identified by the subject advisor of the Grahamstown area. For the learners, the inclusion criteria was as follows: (1) only learners in grades 1-6. (2) Learners from a disadvantaged school as identified by the subject advisor of the Grahamstown area. (3) Learners who reside in the Joza Location, Grahamstown. (4) Learners who brought back research participation permission slips (more on this in the procedure section, also see Appendix C). (5) Learners who were present on the day of testing. (6) Learners with brain injuries, learning disabilities and a poor school attendance were excluded from the research study. According to the school teachers, all learners in the grades of testing could be included in the study as none of them violated the inclusion criteria. It is important to note that there was no medical information of the participants in the school system to corroborate any of the medical conditions for the participants (i.e. brain injuries, or learning disabilities).

3.5 MATERIALS

3.5.1 The VASSI. The bilingual (English and isiXhosa) versions of the Vassiliou Mathematics Proficiency Foundation Phase Test (Grades 1-3) as well as the Vassiliou Mathematics Proficiency Test (Grades 4-6) were used to gather data for this research study (See Appendices D to O). The VASSI is an assessment instrument which intends to distinguish mathematical proficiency in children from an early age (Vassiliou, 2000). According to its creator, the VASSI is based on the mathematics curriculum in South Africa, and as such taps into various types of mathematical reasoning required by the mathematics syllabus (Vassiliou, 2000). The VASSI's content juxtaposes the cognitive processing expected from a child at a particular age of their cognitive maturation (Vassiliou, 2000). In this way, the test allows for the pinpointing of any mathematical problems the child might encounter in their mathematical development.

The *Vassiliou Mathematics Proficiency Foundation Phase Test* (grades 1-3) and the *Vassiliou Mathematics Proficiency Test* (grades 4-6) were created in the year 2000 and 2003 respectively (Vassiliou, 2000; 2003). The *Vassiliou Mathematics Proficiency Foundation Phase Test* consists of 20 questions based on the mathematics curriculum at the time. These questions were standardised on a sample of English speaking learners from the Free State region and later norms were created for the Afrikaans and Sesotho speaking learners in that province. There is a different test for each of the three grades in this phase.

The *Vassiliou Mathematics Proficiency Test* also consists of 20 questions based on the mathematics curriculum at the time. This test was standardised on a sample made up of

Afrikaans, English and Sesotho speaking learners from the Free State. Similar to the *Vassiliou Mathematics Proficiency Foundation Phase,* there is a different test for each grade on this instrument.

Both tests contain “story sums”, because the test is not one of language proficiency but of mathematics proficiency, the words may be explained to the learners. Calculators are not allowed on the tests (Vassiliou, 2000;2003).

3.5.2 Reliability and Validity. The VASSI has demonstrated high reliability and validity. With regard to reliability, using the Kuder-Richardson measure, a reliability coefficient of 0.80 was reported (Vassiliou, 2003). In the grades 1, 2, 3, 4, 5 and 6 subtests of the test, reliability coefficient of 0.85; 0.83; 0.87; 0,80; 0,87 and 0,82 respectively, were reported indicating the reliability of the measure (Vassiliou, 2000; 2003). Regarding test-retest reliability each of the grade 1, 2 and 3 tests obtained a test-retest reliability correlation coefficient of 0.30; 0.593 and 0.690 respectively, with the test-retest reliability significant for each grade level ($p < 0.01$) (Vassiliou, 2000). With regard to face validity, mathematics teachers reported being pleased with the content of the test (Vassiliou, 2000, 2003). Moreover, according to Vassiliou (2000), the predictive validity of the test is significant at the 0.01% level.

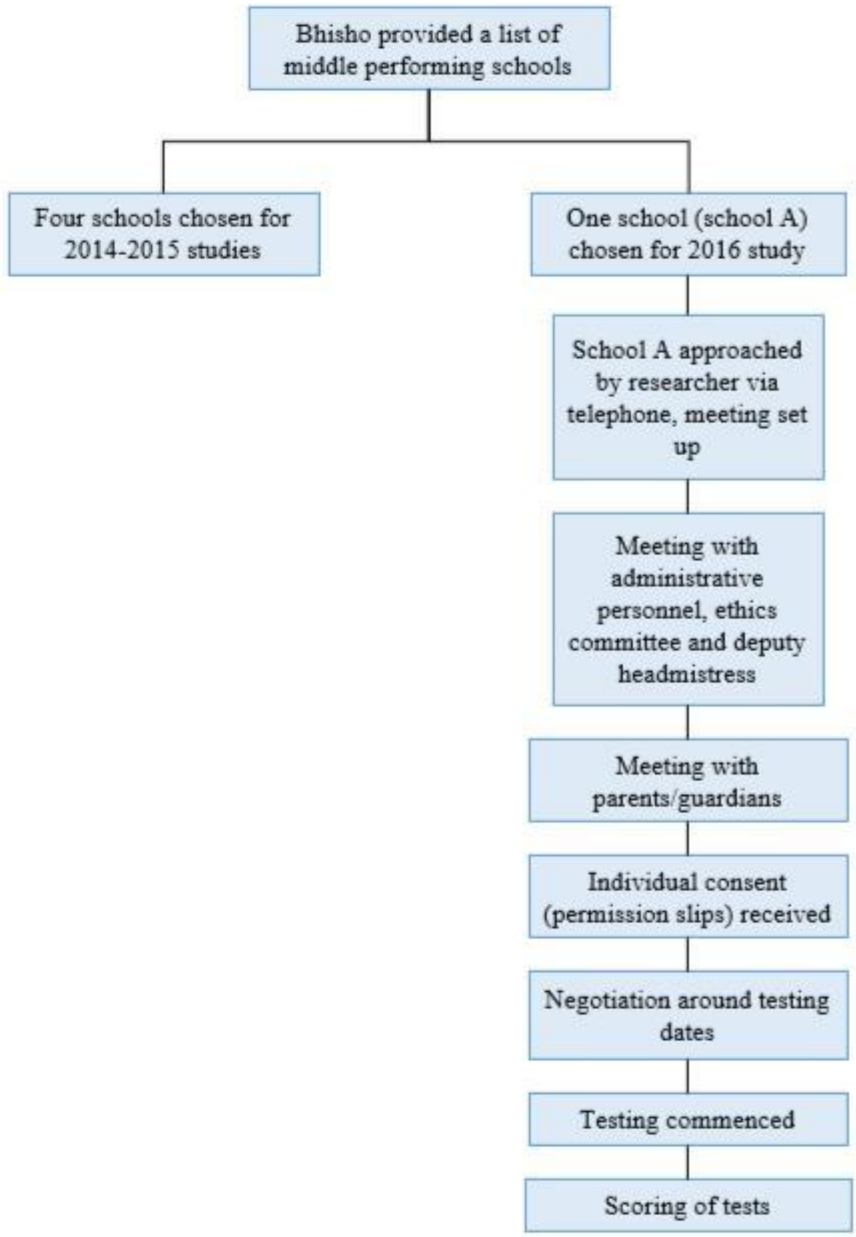
3.5.3 Translation. The original VASSI is currently available in Afrikaans, English, and Sesotho. At the time of the pilot phase of my research, the VASSI had to be translated into isiXhosa for my research purposes. A series of phases were undertaken which included verbal permission being obtained from Dr Vassiliou, the creator of the VASSI. The translation process was then as follows: (1) The English version of the test was translated to isiXhosa by a qualified remedial isiXhosa teacher, (2) the test was back-translated to English by an isiXhosa speaking Psychology Masters student (myself), to assure that the essence of the questions was not lost. As previously mentioned the learners are all isiXhosa speakers. Grades 1-3 are taught in their mother tongue and only learn English starting in Grade 4. According to Foxcroft and Roodt (2006), back-translation plays an important role in assessing the equivalence of translation. There were no concerns about the construct validity because the English questions were accompanied by the isiXhosa questions. Furthermore, Vassiliou (2000; 2003) explicitly states in her manuals that the assessment is not about language comprehension and if need be, questions may be explained to the research participants. The translation was merely for the convenience of the test-takers as not all participants were proficient in the English language.

3.6 PROCEDURE

3.6.1 Introduction. This section focusses on the administrative and practical considerations which were adopted from the beginning through to the final stages of the research. A concise and easy to understand diagram of the procedures undertaken to collect my data are detained below, followed by a more in-depth explanation.

Figure 3.1

Procedure concerning administrative and practical considerations



3.6.2 Administrative considerations. Before administering the VASSI, the researcher met with some administrative personnel at school A. A single meeting was held with the principal, vice principal, teachers as well as the ethics committee and the governing body of the school to inform them of the purposes of the study, its merits and usefulness.

After obtaining permission from the management of the school, a meeting was held with the parents/guardians of the pupils to inform them of the study as well as to ask for their, as well as their children's permission. After individual consent was attained, in the form of permission slips, (and assent from the children) negotiations around testing dates commenced.

3.6.3 Practical Considerations. Initially, it was the researcher's vision that a week prior to testing, a training session with the teachers would be done. However, this was seen as unnecessary as the vice principal and teachers felt that the previous discussions which were held during the planning phase were sufficient. The researcher was then provided with the school timetable which showed the allocated time-slots for the math classes of each grade. The researcher was to use this timetable and test each class accordingly, as not to disrupt the school's already existing routine. On the first day of testing, the researcher was to test class 2A (according to the math timetable), however, upon arrival, the researcher was informed that the entire second grade (class 2A and 2B) would be tested. After testing the grade 2 classes, the researcher approached the deputy headmistress regarding the change of plan. The researcher was informed that testing was to be done per grade as opposed to each class and the time and day for testing would need to be arranged with the teachers. Testing was done in the month of July in the mornings, starting from 8 am. Data collection for school A took a period of 6 days to complete. Testing this late in the year was not problematic as Vassiliou (2000; 2003) stated that the VASSI could be administered to groups and individuals at any point during the academic year, this highlights the flexibility and usefulness of the test for both diagnostic and normative purposes.

Data collection for the entire research study (including the pilot studies) spanned over a period of two years.

3.6.4. Data Collection. On the day of testing, the VASSI test booklets were placed face down in front of each learner. Once each learner had a booklet, they were instructed to begin completing the VASSI test simultaneously. The learners were directed to the first page of the test booklet, and for the lower grades (1-3) the test questions were read out to them either by the researcher or class teacher. There were two reasons behind this, the first being pragmatic, in the sense that the teachers stated that this was the approach to class tasks as well as completing tests. Secondly, children in the lower grades struggle with reading isiXhosa and are not taught English in these grades. There were no time limits set for the test. However, the grade 1's took an hour and fifteen minutes to complete the test; the grade 2's took two hours thirty minutes; grade 3's took an hour and thirty minutes; the grade 4's took an hour and twenty minutes; the grade 5's took an hour, and the grade 6's took an hour and thirty minutes. I remained in the test venues until all learners were finished. All data was collected by the researcher of the project with some assistance from the school teachers. At the end of the testing session, the booklets were collected and placed in an envelope on which was written the grade, class specifier (e.g. Class 2A), the number of learners who wrote the test for that particular grade, the class teacher's name, and the date and time of testing. After this I left the venue.

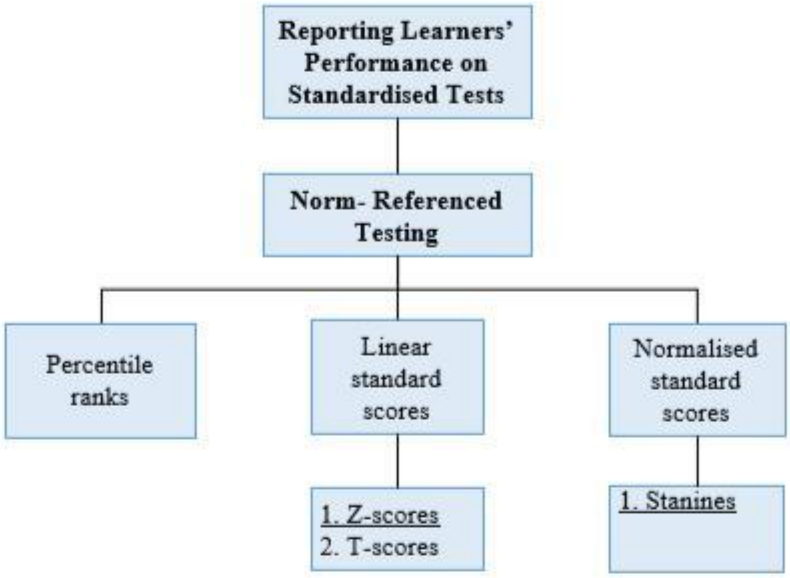
3.6.5. Scoring. Scoring of the tests was done according to the instruction of the VASSI manual where a correct response is allocated one mark (1) and an incorrect response allocated a zero (0) (Vassiliou, 2000; 2003). In cases where part of the question was incorrect, the whole question was marked wrong, and a zero was allocated. The marks were then added to give a total raw score out of 20 (all tests were out of 20). All data including the raw scores was immediately saved onto Excel for further statistical analysis.

3.7 DATA ANALYSIS

3.7.1 Methods of analysing the data and scores.

Figure 3.2

Adapted Summary of Methods used in Reporting Learner's Scores (Mertler, 2007)

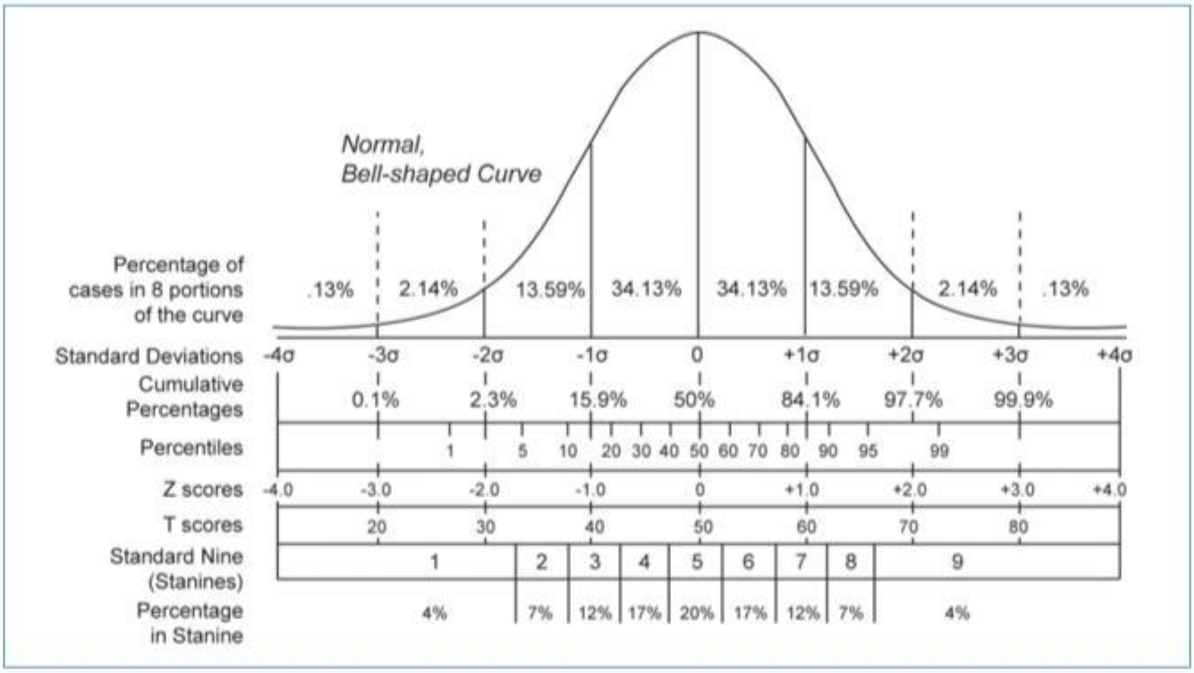


Data collected from this study was combined with that of the pilot studies and analysed jointly. Descriptive statistics were primarily used to analyse my data. The methods of reporting norms and scores on standardised tests was adopted from Mertler (2007) and is shown on Figure 3.2. My research used norm-referenced testing to derive preliminary norms for the VASSI test, as opposed to the criterion- referenced format. Norm-referenced testing is a form of testing where scores are distributed in a bell-shaped curve (as shown in Figure 3.3) and thus interpreted according to the bell-shaped curve (Robinson Kurpius & Stafford (2006). The bell-shaped curve depicts what is normal in a distribution and shows the relationship between standard deviations, z- scores and stanines, just to name a few, the variables used in my research. In norm-referenced testing, unlike in criterion-referenced testing, the learner's score is comparable to those of others within their norm-referenced group (Mertler, 2007). Within norm-referenced testing, percentile ranks, linear standard scores (z scores) and normalised standard scores (stanines) are used in reporting the learner's scores.

The above processes led to the creation of normative data tables. All this is outlined in detail in the Results chapter.

Figure 3.3

Characteristics of a Normal Distribution



3.8 ETHICAL CONSIDERATION

Approval for the study was granted by the Department of Education of the Eastern Cape (Bhisho) (Please see Appendix A) as well as by the Rhodes University Ethics Committee (approval number RU-HSD-15-06-0004: Please see Appendix B). This research involved working with minors who are considered a vulnerable group, however, since the

VASSI is a non-psychological test, no harm to the children was anticipated. The test uses items found in the Department of Basic Education mathematics curriculum. Therefore no undue distress was expected. However, test taking, no matter how familiar the learners may be with the test content, may be anxiety provoking. To maintain comfort and low levels of anxiety for the children, the teachers were present during testing. To ensure anonymity, the children’s individual marks were not reported back to the school, nor was the school shown the results of the research project. The parents of the children, teachers and children were informed of voluntary nature of the project as well as that they could pull out of the research study at any stage within the research. All this information was verbally communicated to all parties involved in the study and was also written in the consent form (which included a tear-off sign slip) that all parents signed (see Appendix C).

CHAPTER FOUR

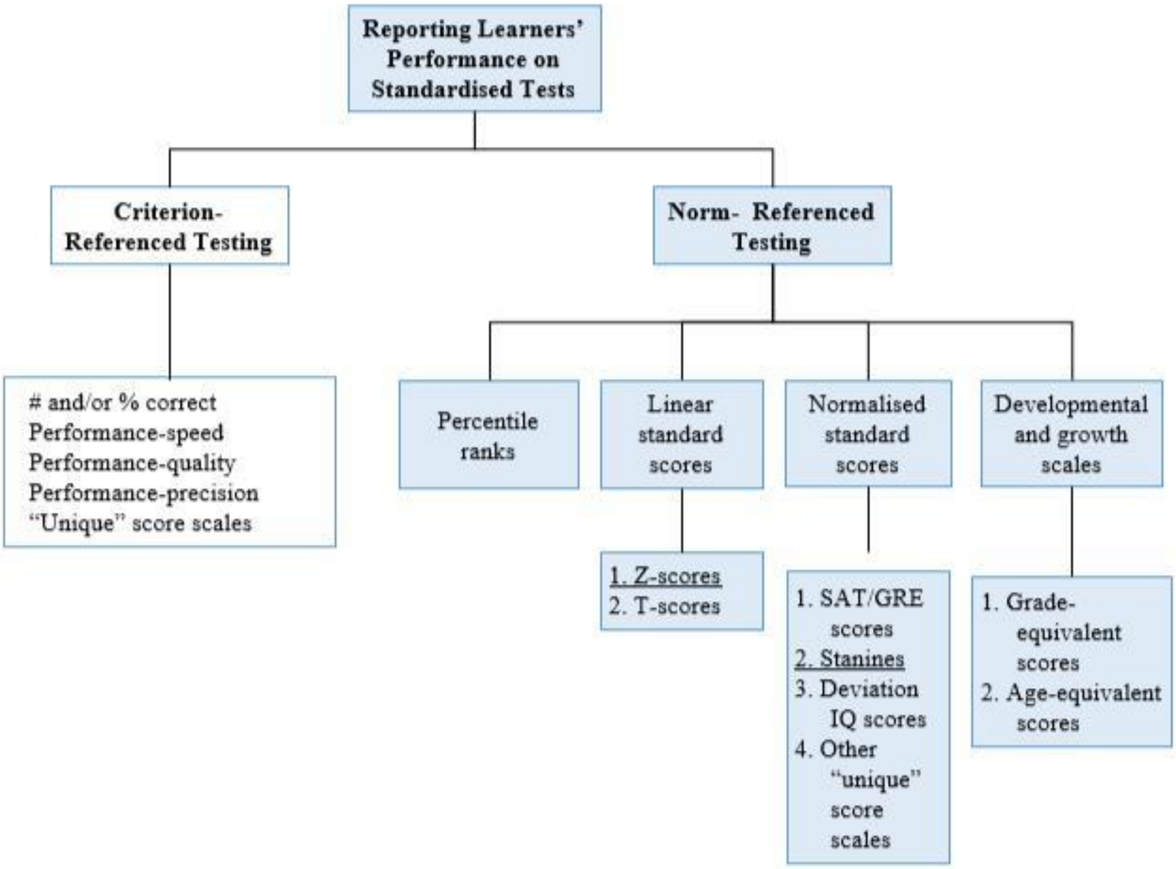
RESULTS

4.1 INTRODUCTION

As previously stated, the aim of this research was to derive norms on the *VASSI* Mathematics Proficient Test for a sample of grade 1-6 learners in disadvantaged schools in Grahamstown, Eastern Cape. The subsequent sections will report on my findings. A description of the sample, based on age is first presented; followed by descriptive statistics. Norm references in terms of linear standard scores (converting raw scores to *z* scores) and converting these to normalized standard scores (stanines) are then presented. This method of norming is based on the suggestions of (Mertler, 2007) as represented below.

Figure 4.1

Summary of Methods of Reporting Scores on Standardised Tests (Mertler, 2007)



4.2 DESCRIPTION OF THE SAMPLE BASED ON AGE AND GRADE

Table 4.1 presents the average age for each Grade. Participants' were aged between 5 and 11 years of age. The average age of Grade 1 was 7 years of age (SD =0.89) and 12 years of age (SD = 1.01) for Grade 6. Large discrepancies were observed between minimum and maximum ages in each of the Grades and these could have had an effect on the results obtained.

Table 4.1

Age of Sample for Each Grade

Grade	Mean Age	Median	Standard Deviation	Maximum Age	Minimum Age
1	6.72	7	0.89	10	5
2	7.66	8	0.86	11	7
3	8.86	9	0.74	12	8
4	10.10	10	0.96	13	8
5	10.97	11	1.03	15	9
6	12.31	12	1.01	16	11

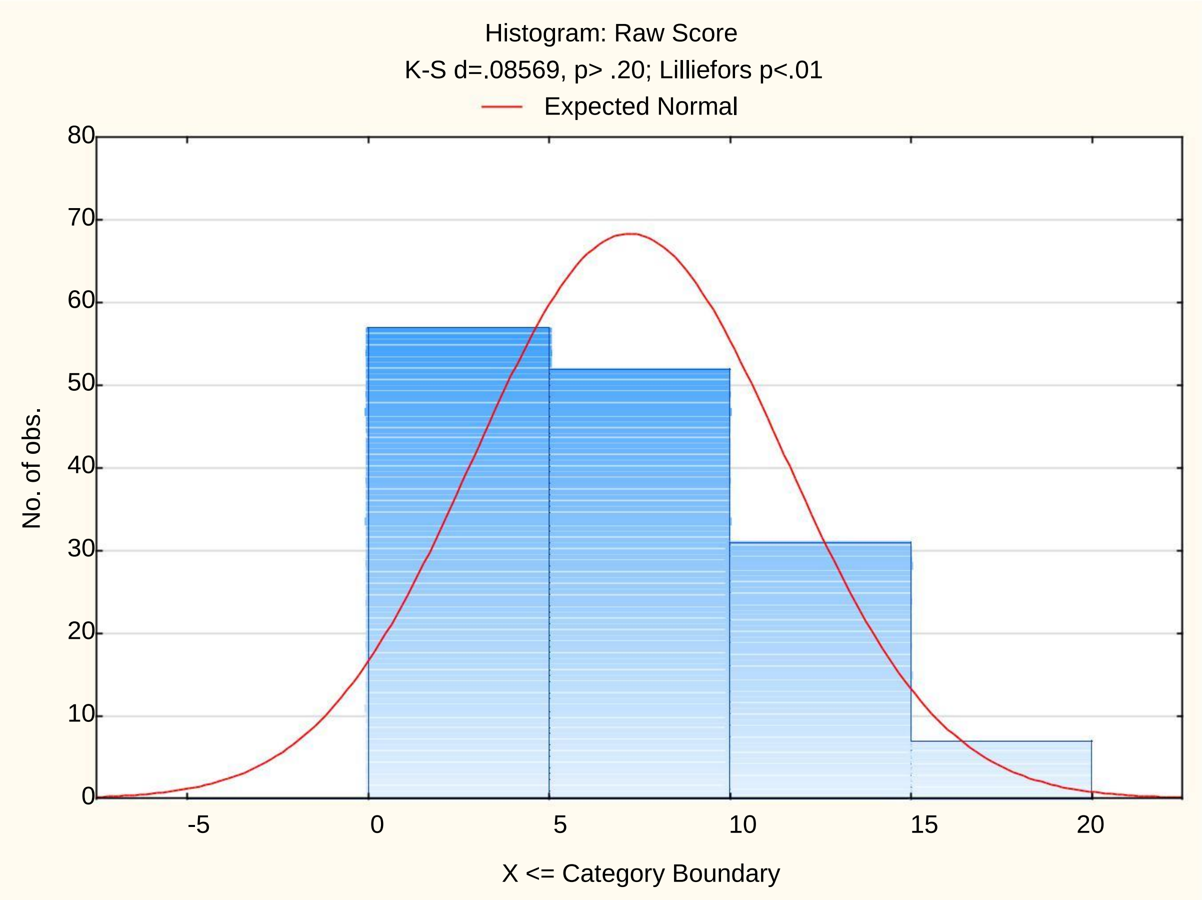
4.3 STATISTICAL PROPERTIES

4.3.1. Descriptive Statistics

4.3.1.1. Normal Distributions. I first ran a number of histograms for each Grade on their performance on the VASSI using Kolmogorov- Smirnov and Liliefors test for normality to assess if my data was normally distributed on the main variable, the raw score. Graph 4.1 is the histogram for Grade 1 scores. The results were as follows $d = 0.08569$, $p > .20$, indicating normality for the Grade 1 group. The Grade 4 group obtained similar results indicating non-significance, thus normality. This is congruent with the skewness and kurtosis results reported below. The results were significant for Grade 2 $d = 0.16581$, $p < .01$; Grade 3 $d = 0.13843$, $p < .05$; Grade 5 $d = 0.14354$, $p < .05$ and Grade 6 $d = 0.17728$, $p < .01$ indicating that these groups deviate significantly from normality. This is in conflict with the skewness and kurtosis results. For ease of reading, the rest of the histograms can be seen in Appendices P to T.

Graph 4.1

Grade 1 Normality Histogram



4.3.1.2. Measures of central tendency. Measures of central tendency were used to determine a number of statistics including the mean, mode, and median of the data. The dispersion of the data was also explored. A summary of the descriptive data for each Grade, on the performance on the VASSI can be seen on Table 4.2 below.

Table 4.2

Descriptive statistics of grades 1-6 performance on the VASSI (The Total Scores for the VASSI is 20 marks)

Grade	Mean[8]	Median	Standard Deviation	Range	Max Score	Min Score	Skewness	Kurtosis
1	7.22	7	4.29	17	18	1	0.41	-0.58
2	4.31	3	4.16	17	17	0	0.97	0.13
3	5.21	5	3.1	13	13	0	0.65	-0.43
4	4.85	5	2.86	13	13	0	0.45	0.07
5	3.76	3	2.46	10	10	0	0.51	-0.41
6	5.18	4	4.03	15	15	0	0.62	-0.88

For grade 1 the mean score on the VASSI was *M* =7.22 with a large deviation of 4.29 indicating that the VASSI scores are widely spread apart from the mean. For grade 2 *M*=4.31 was obtained from 123 participants, with SD =4.16. The grade 3 normative sample of 117 obtained *M* =5.21 with *SD*=3.1. For grade 4 *M*=4.85 was obtained from 128 participants, with SD=2.86. The grade 5 sample of 113 participants obtained *M* =3.76, with SD=2.46. For grade 6, *M* =5.18 was obtained from 96 participants, with SD =4.03.

Skewness measures how deviant a score is from the norm (Mertler, 2007). An ideal variation, or skewness according to Mertler (2007) is between -3 and +3. Positive skewness indicates that learners' scores were lower than the mean and this occurs when a test is too difficult, the opposite is applicable to negative skewness. Since the skewness values are only slightly above zero this indicates a more symmetrical distribution of scores, the positive sign

[8] This represents the mean score for each Grade out of 20

shows that the test was difficult for the learners. Kurtosis refers to how flat or peaked a distribution is (Mertler, 2007). The kurtosis of all grades except for grade 2 is negative, this indicates that the distribution is more flat however the values are so small that it could be seen as a normal distribution. The grade 2 kurtosis is positive indicating a more peaked distribution, once again the value is very small indicating that this could be viewed as a normal distribution.

4.3.2 Determination of norms

4.3.2.1 Standardisation. The following section focusses on the process which was used in standardising the raw scores obtained by each grade.

(a) Z Scores.

As stated above, there are many ways in which learner's scores can be reported, however, for this research, *z*-scores were converted into stanines, percentiles were also used. According to Mertler (2007), all norm-referenced scores on the normal distribution provide the same information regarding where the raw score falls. Raw scores were first converted to z scores using the formula:

Table 4.3

Converting Raw Scores to Z-scores: Grades 1-6 performance on the VASSI

	Mean VASSI Score out of 20	z-score
Grade 1	7.22	0.00
Grade 2	4.31	-0.00
Grade 3	5.21	-0.00
Grade 4	4.85	0.00
Grade 5	3.76	0.00
Grade 6	5.18	-0.00

(b) Stanines.

Following from above, the z scores were converted into stanines (standard nine). The Stanine Conversion Table was used to transform the standard scores to a scale running from 1 (extreme low end) to 9 (extreme high-end), with a mean of 5 and a standard deviation of 2 (Mertler, 2007). According to Mertler, (2007), the conversion of z scores into stanines involves multiplying the z score by 2 (the standard deviation on the above mentioned scale) then adding 5 (the mean on the above mentioned scale) to the resulting value.

The Stanine Conversion Table (Table 4.4 below) was used to correlate each z score to a stanine rank. This allowed for easy comparisons to be made with respect to analysing elements within the data set. This method of standardisation of norms is easy to understand, it has no negatives or decimals variations (Rust & Golombok, 1999). Table 4.3 shows the results of the conversion of raw scores for each grade, scores into z scores. Graph 4.2 illustrates the stanine scores on a normal distribution graph.

Graph 4.2

Distribution of Scores in a Stanine Histogram

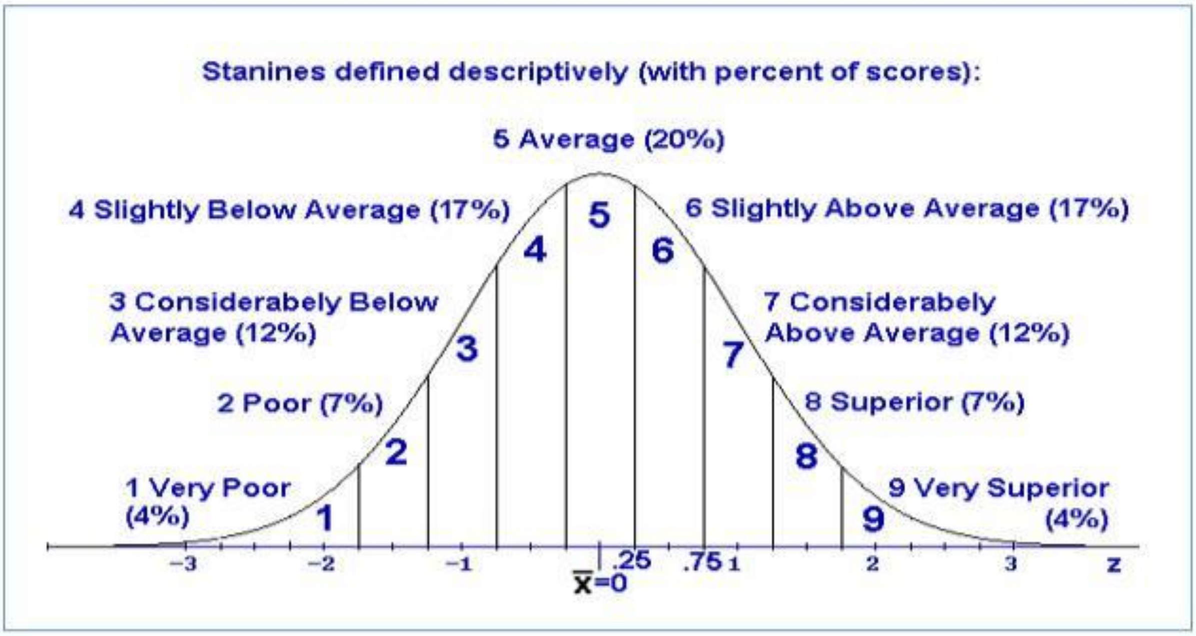


Table 4.4

Z-score to Stanine Conversion Table

Stanine	Minimum z-score	Maximum z-score	% of population in each stanine	Cumulative % of population
1	- ∞	-1.75	4	100%
2	-1.75	-1.25	7	96%
3	-1.25	-0.75	12	89%
4	-0.75	-0.25	17	77%
5	-0.25	+0.25	20	60%
6	+0.25	+0.75	17	40%
7	+0.75	+1.25	12	23%
8	+1.25	+1.75	7	11%
9	+1.75	∞	4	4%

Table 4.5

Converting Z-scores to Stanines: Grades 1-6 performance on the VASSI

	z-score	Stanine	Percentile
Grade 1	0.00	4.91156 (5)	47
Grade 2	-0.00	4.87805 (5)	45
Grade 3	-0.00	5.05128 (5)	45
Grade 4	0.00	4.96875 (5)	45
Grade 5	0.00	5	44
Grade 6	-0.00	4.84375 (5)	46

c) Percentile Rank.

The raw scores were also converted, using Excel, into percentile ranks. In this way, the individual learner is easily compared to other learners in the norm group. Converting score into percentile ranks makes use of the following formula:

$$= \times 100$$

Where *PR* (percentile rank) equals to *cf* (cumulative frequency which corresponds to the score in question) divided by *N* (the number of people in the distribution), multiplied by 100 (Robinson Kurpius & Stafford, 2006). For my research, excel was used to calculate the percentile ranks of the scores.

The following is an explanation of the information illustrated in Table 4.5 above.

The average z-score for the grade 1 learners was 0.00105 (rounded off to 0.00), the stanine is 4.91156 (rounded off to 5), and the percentile rank is equal to 47. This means that when compared to the normal distribution the grade 1 learners are in the average range, they performed better than 47% of other learners in the norm group.

On the normal distribution the grade 2 learners are within the average range and according to their percentile rank have performed better than 45% of learners in their norm group. The Grade 3 learners are within the average range and have performed better than 45% of learners in the same norm group. The Grade 4 learners are within the average range according to the normal distribution bell curve and have performed better than 45% of learners in the norm group. The grade 5 learners are within the average range and have performed better than 44% of other learners in the same norm group. The grade 6 learners' performance on this test is within the average range, and they have performed better than 46% of other learners in the same norm group.

The above process was done for each individual learner scores, leading to the norm tables for each grade. These tables can be found in appendices U to Z.

4.4 INCIDENTIAL FINDINGS OF INTEREST: INFERENTIAL STATISTICS

4.4.1 t-test. Although not a key component of my thesis, t-tests analysis were done on the raw scores based on gender. An independent samples t-test showed a statistically significant difference between males (M = 4.05, SD = 2.21) and females (M = 5.71, SD = 3.22), t = 3.42, p < 0.05 (d= 0.61) on the Grade 4 VASSI raw scores. Similar, differences were found between males (M = 3.33, SD = 2.33) and females (M = 4.25, SD = 2.54)), t = -1.99, p = 0.05 (d= 0.38) on the Grade 5 VASSI raw scores. All other analysis were not significant by gender. A summary of these key findings are presented below on Table 4.6.

Table 4.6

t-test results

	Variable	Mean Male	Mean Female	t-value	p	Brn-Fors F(1,df)	p Brn-Fors
Gr 1	**Raw Score**	7.05 (4.33)	7.45 (4.26)	-0.57	0.57	0.14	0.71
Gr 2	**Raw Score**	3.65 (4.33)	4.84 (3.97)	-1.58	0.12	0.00	0.98
Gr 3	**Raw Score**	4.71 (2.99)	5.66 (3.16)	-1.65	0.10	0.21	0.65
Gr 4	**Raw Score**	4.05 (2.21)	5.71 (3.22)	3.42	0.00	4.58	0.03
Gr 5	**Raw Score**	3.33 (2.33)	4.25 (2.54)	-1.99	0.05	0.03	0.86
Gr 6	**Raw Score**	5.49 (4.20)	4.85 (3.87)	0.77	0.44	0.69	0.41

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

This chapter aims to put together as well as provide possible explanation to the above information presented in the Results chapter. The information will be reported as follows: The VASSI, age differences, score mean differences, gender differences according to the t-test performed and the overall performance of the learners. Important to bear in mind when interpreting the results is that the mathematics curriculum has since changed since the date of the creation of the VASSI.

5.2 THE VASSI

The date of norming, according to those in the field of norming and assessment, is important when interpreting test scores (Sattler, 1992; Mitrushina, Boone, Razani & D'Elia, 2005; Strauss, Sherman & Spreen, 2006). This is because of the Flynn effect in which there is a "trend towards increased IQ scores (0.3 points per annum) over time with each subsequent generation", therefore, the 'lifespan' of a normed test is approximately 15 to 20 years (Strauss, et al., 2006, p. 45). According to Mitrushina, et al. (2005) new norms need to be generated in order to guard against the Flynn effect as well as to ensure that tests remain current. The authors further state that the rising IQ scores could be as a result of increasing access to information which in turn increases the learner's fund of knowledge. Neisser, Boodoo,

Bouchards, Boykin, Broday, Ceci, Halpersn, Loehlin, Perloff, Sternberg & Urbina as cited by Strauss, et al. (2006) state that testing experience, improved nutrition, school and child-rearing changes and cultural changes could be other possible reasons for this increase. The scores of the learners in my study may have been overestimated as a result of the Flynn effect.

In light of the above, as well as the above stated dates of the creation and norming of the VASSI, more recent norms need to be created.

5.3 NORMALITY, SKEWNESS AND KURTOSIS

According to the Kolmogorov-Smirnov test of normality all other grade scores apart from those of Grades 1 and 4 significantly deviated from normality. This is not in agreement with results obtained from the skewness and kurtosis test which showed that all scores are normally distrubuted. For the Kolmogorov-Smirnov test large sample sizes tend to yield parameters which are more restrictive making it difficult to declare the data as normally distributed, and because of the large sample sizes the distribution of data can be viewed as normal (Testing for Normality, n.d., slide 11). This could account for the difference obtained between by these methods of testing normality.

5.4 AGE DIFFERENCES

The age differences (in table 4.1) show that some schools in the Grahamstown area have an older population than would normally be expected, this could be due to grade repetition. This is evident in the maximum ages of each grade. In grade 1 the difference between the minimum and maximum age is 5 years, in Grade 2 it is four years, in Grade 3 four years, in Grade 4 five years, in grade 5 six years and in grade 6 five years. This highlights the status quo in many primary schools in these regions; it is for this reason that these outliers were included in the study. The teachers of school A state that the maximum ages should be much more in number and much higher in age, however, the government's rule of condoning children due to age masks this. “Condonation” is defined as the “relaxation of promotion requirements” (Department of Basic Education, 2011, p.8). According to the Department of Education (2011) report “a learner who does not meet the requirements for promotion can be progressed to the next grade in order to prevent the learner being retained in the Foundation Phase for longer than four years, excluding Grade R”. This means that a learner can only be held back once in each school phase. This results in learners being promoted to higher grades without having obtained the necessary information needed for that grade. As previously mentioned one of the three principles in Piaget’s theory, the hierarchical principle, states that a child has to go through each stage before moving on to subsequent stages, and that all that is learned in that stage forms the foundation for the next (Ojose, 2008; Vassiliou, 2000).

In such a system where learners are condoned even though they have not met the requirements for a promotion to the next grade, it is not surprising to find these large gaps within the minimum and maximum ages. It is also not surprising to see the overall poor performance of learners on the VASSI. Assuming that the older learners who have been condoned have not attained the necessary information to succeed in the higher grades, it stands to reason that these learners lower the overall mark of the grade.

Mentioned in the literature is that the age range for completing primary schooling in the Eastern Cape is 15, this is two years above the expected age of completion of 13 years (Statistics South Africa, 2013). Also, 21.3 % of grade 1 learners are older than the expected age range for that specific grade and by the time they get to grade 7 61.7% of them are older (Statistics South Africa, 2013). The figures from the sample used in this study are not very far from these. Although the researcher was unable to comment on the average age of completion as the chosen sample did not include grade 7 learners, the maximum age in the grade 6 population was 16 years with 34.4% of them older than the expected age for this grade and 17.7% of the grade 1 learners were older than the expected age for that grade.

5.5 SCORE MEAN DIFFERENCES

According to Vassiliou (2000) the tests for each grade differ significantly, this renders the score means as incomparable as different math competencies are expected from each group. Despite this the researcher looked at the raw score differences of each grade.

From table 4.2 it is evident that the grade 1 learners obtained the highest average score of all the grades, however, the grade 1 learners also have the highest number of participants. One of the criticisms by neo-Piagetian theorists is that Piaget's theory underestimates the abilities of children in the early stages. The math curriculum incorporates Piaget's theory in its formulation as it recognises that children go through stages of development where certain thought processes are expected, this curriculum also incorporates the concept of conceptual knowledge (referred to by Piaget as logico mathematical knowledge) (Department of Basic Education South Africa, 2012). Perhaps the same could be said for the mathematics curriculum in terms of underestimating the abilities of young children although no evidence in support of this was found. This could be the contributory factor to the high scores obtained by the grade 1 learners.

The average scores of the sample drop significantly from grade 1-2, once again this could be due to the number of participants. Important to note is that a large number of learners in grade 2 are 7 years old, this renders these children as young for this grade which usually has children aged 8 years old. Age 7 is found in both the preoperational and concrete operational stages and as previously mentioned there are development processes expected at each of these stages. Once again learners who have not fully developed within each stage will struggle with tasks expected of them in the next stage. Perhaps some of these 7 year olds in grade 2 are still in the preoperational stage and have not developed the thought processes required to do well in mathematics tasks found in the concrete operational stage. Vassiliou

(2002) states that primary school mathematics is dependent on the mental operations which are acquired in the concrete operational stage and failure to acquire these operations renders the learner as unable to move on to the more advanced levels of mathematics.

Grades 2 to 4 have scores which are not far from each other, once again this could because these learners all fall within the concrete operational stage, thus the same is expected from them. The grade 5 learners obtained the lowest mean score of all the grades. Despite being the lowest in number the grade 6 learners achieved the 4th highest average score on the test.

There was no particular pattern in terms of the scores as they started high when looking at grade 1s, fell with the grade 2s, rose again with the grade 3s and 4s, a significant dip was evident in the grade 5s, however the scores rose again with the grade 6s.

5.6 GENDER DIFFERENCES

Research shows that boys and girls perform equally well in mathematics in early adolescence (Mullis, et al., 2000; Mussen et al., 1990). In the determination of norms, t-tests for independent groups were done and it was found that there were no significant differences between males and females across all other grades except for grades 4 and 5. These results indicate a gender effect in the direction of the female group performing better than the male group in both grades on the Vassi Math Proficiency Test. This is in conflict with the above statement. Cohen’s d was calculated for both grades to calculate the effect size, the grades 4 yielded a large effect size and the grade 5 learners obtained a medium effect size. This made it difficult to compare gender scores between the grade 4 and 5 learners. However, at face value it is evident that the female learners outperformed the male learners across all other grades except for the grade 6 learners where the males outperformed the females.

5.7 THE OVERALL PERFORMANCE OF THE LEARNERS

The mean scores of each grade are well below the 50 percent score expected in the test. However, as previously mentioned, one cannot compare scores of learners without appropriate standardisation of the scores. This process of standardisation included converting raw scores into stanines and percentile ranks. This then made the scores comparable, it also allows testers to make appropriate conclusions on a learner’s performance. The low score levels could be due to the various factors named in the literature review, namely, the state of township schools, education and social class divide, poverty and low socio economic status, quality of teachers and teaching and other cognitive barriers experienced by the children of the Eastern Cape. The following barriers were the ones that the researcher had capacity to comment on. Education and social class divide, and poverty and low socio economic status are topics that the researcher could not comment on because the researcher did not sit in on any classes to view how the teachers taught neither did the researcher use a standardised form of assessing the socio economic status of the learners in the sampled schools. To start off the researcher looks at the concrete problem solving strategies employed by the learners.

5.7.1 Concrete problem solving strategies. A number of common errors were noted on the grade 1 and grade 2 test papers. These include number reversals as well as number repetition. Number repetition was mostly found in division questions. Although these responses did not indicate the correct responses as given by the VASSI marking guidelines they were, after careful consideration, marked as correct. It was evident that the problem was not in understanding the question and in how to respond to it but the problem was in the learners’ understanding of how numbers are written. The strategies used by the learners for solving the math problems consisted of drawing small lines or “eggs” on a page and using these for counting. On questions where the learners had to calculate large numbers, for example 571-348 the learners first drew 571 lines or eggs then 348 lines or eggs, count the total number of items they have drawn then subtract 348 from this total by crossing out 348 lines or eggs then recounting the remaining lines or eggs. This resulted in many errors due to miscounting. In multiplication questions such as 1500x5 the learners drew 1500 lines or eggs 3 times and then counted the total. The same pattern was noted for addition problems. This took a considerable amount of time. These strategies also highlighted the learners' inability to work with 3 digit numbers. Research done by Hoadley (2007) noted the difference in strategies employed by learners from previously model c schools and those employed by learners in township schools. Learners in the more affluent schools employed more mathematical procedures such as "quick mental calculations" whereas learners from the disadvantaged schools employed more concrete forms of calculating answers (Hoadley, 2007).

Nell (1999) also includes test-wiseness as one of the demographics which play a role in psychometric test performance. She further describes test-wiseness as those skills such as pencil grip, fluency in reading and being able to copy tasks, working with speed and accuracy, sitting still during testing. These skills are attained through formal schooling where learners are constantly exposed to testing situations. Test-wise learners also know that they need to stay motivated and alert when taking tests. Nell (1999) also recognises that in countries like South Africa being formally educated does not equate to receiving quality education (Nell, 1999). It is in schools which offer a higher quality of education that test-wiseness skills are often found (Hambleton, 1994). This means that learners in disadvantaged schools where the quality of education is questionable are less likely to possess such skills and are more likely to perform poorer than those in advantaged schools. A large number of learners in the sample struggled with pencil grip and majority of the learners struggled to sit still. This could have potentially added to the low results obtained by these learners.

5.7.2 The state of Joza Township schools. The schools from which the sample comes from were very much like those discussed in many papers which talk about disadvantaged schools. These schools only have one computer and one copy and fax machine. They do not have a computer lab or a library that the learners can use. In the classroom, desks which are meant for two learners often sat three or even four learners. At one of the schools, just a few minutes before testing commenced, a fight broke out between learners over a chair. During testing many of the learners had no stationary and often had to borrow from others around them. This resulted in poor testing conditions as there was a lot of noise from learners calling out to those who had stationary or walking up to them many times to get the stationary they needed. The teachers reported inadequate learning materials as many learners have to share math text books, amongst others, due to a shortage. This results in learners not being able to complete homework tasks. As noted in many articles, for example Crouch and Mabogoane, 2001; Lemon, 2004; Spreen and Vally 2006, the above factors have a negative effect on a learner's performance in mathematics and other school subjects. The "not up to standard" conditions of testing may also have a contribution to the low performance of these learners.

5.7.3 Low socio economic status. It is important to note that the researcher did not use any formal way of assessing the socio economic status of the learners in the sampled schools. The researcher relied on qualitative assessment as well as testimonies from the class teachers. As previously mentioned, socioeconomic status has an impact on the learner's achievement in school. Some researchers state that a learner's performance and achievement in school is highly dependent on their socio economic status (Bradley & Crowyn, 2002; Statistics South Africa, 2013; van der Berg, 2008). According to the teachers majority of the learners in the schools are on a social welfare grant and a lot of these learners do not have the stationary required by the school. The teachers also added that some of these learners come from poverty stricken homes where the only source of income is the child's social welfare grant. The teachers also reported alcohol abuse and lack of care by parents/gaurdians of the learners. As previously mentioned majority of the learners do not complete homework tasks, the teachers state that this is due to a lack of care from the parents. Howie (1997) reported that many parents in South Africa only have a basic primary school education, this may be one of the reasons why parents struggle to help their children with homework tasks.

5.7.4 Quality of teachers and teaching. The teachers also reported inadequate staff members. One of the four schools had one teacher per grade and there were two classes in each grade each with approximately 45 learners. Apart from being overworked these teachers seemed tired and lacked motivation and reported being unable to give the learners the necessary individual attention most of them need at times. The teachers stated that often they have to move on to new sections in mathematics even though it is clear that the learners have not fully grasped the concepts. They do this because the curriculum stipulates the day-to-day and even minute-to-minute mathematical content that needs to be covered (Long & Dunne, 2014). In the same school, during testing, the teacher openly spoke about a learner whom she felt would receive a zero for the test, the teacher then proceeded to call the learner and showed the researcher the learner's work. The teacher then scolded the learner in front of the researcher, erased all of the learner's answers and instructed him to go sit down and "use his brains". After this the teacher pointed out several other learners who according to her "know nothing". According to Cockburn (2005) learners who are negatively labeled by teachers tend to perform poorly in given tasks, they further add that the mood of the teacher determines whether the learner will ask questions during class or not and thus limits the learning of the learner.

Cognitive testing is a western cultural concept which does not take into consideration other cultures' ways of being (Ardila, 2005). A cognitive testing cultural value which was evident in the data collection process of this research was that of speed. The concept of time in the school was different to other schools which value completing the test on time. During testing the teachers constantly reminded the learners to take their time, to not be in a hurry and to make sure that their work was correct. According to Ardila (2005) in some cultures speed and quality often contradict each other, thus rendering speed tests as inappropriate.

5.8 CONCLUSION

The literature reviewed in this study provides numerous reasons for the poor performance of learners in the Eastern Cape, most if not all these are applicable to the learners in this sample. The minimum and maximum ages of learners provided evidence of the status quo of many schools in the Eastern Cape, many learners are much older than expected. However, the school teachers felt that this is not a true representation of the age ranges of learners in the primary schools due to the promotion of learners to higher grades even though they do not deserve to be promoted.

The gender of the learners was also discussed in relation to their performance. T-tests showed no significant differences between the learners' genders and their performance in the test apart for the grades 4 and 5s. Literature states that in the lower grades there is no difference between the two genders, differences start to show in high school and are usually in favour of the males.

The state of the schools which formed part of the sample is very much like those often written about in disadvantaged education articles. The schools' lack of the basic equipment such as tables and chairs and text books for the learners is a major contributor to these learners’ achievement in mathematics as well as other subjects. As already mentioned the researcher did not perform a proper assessment of these learners’ socio economic status or of the quality of teachers and teaching. This rendered it difficult to comment on the effect these two compounding factors on these specific learners’ achievement in the test. However, the qualitative assessment as well as information from the school teachers placed these learners within the low socio economic bracket. It is needless to say that this factor adds to these learners’ overall poor performance on the test.

Adding to this poor performance is the attitude of the teachers towards the learners which was evident during testing. The learners were labeled and were pointed out as those who “know nothing” in the researcher’s presence and as stated in the literature this results in the learners performing poorly in school tasks.

CHAPTER SIX

LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

6.1 LIMITATIONS

One of the main limitiations in this study was that focus was placed on schools in the Grahamstown areas. Surrounding areas such as Port Elizabeth, East London as well as other more rural towns etc. were not included. Inclusion of these towns could have given a more broader and diversified set of norms. Comparisons between the different towns would also have been made possible.

Collection of data was done during the third term, this means that if a learner is tested during the first school term, applying these norms could be disadvantageous to this learner. One way to overcome this would be using the previous year's test and norms when testing this learner.

There was no standardised way of jugding the learners' socioeconomic status, this was done qualitatively as well as by testimony from the school teachers. Socioeconomic status, as previously discussed, is a major contributor to a learner's achievement in learning.
A more standardised form of assessment would have enabled the researcher to draw inferences on the level of socioeconomic status and its affect on the learners' achievement.

Limitations with regards to the test itself were also noted. As previously mentioned the lifespan of a test is approximately 15-20 years (Strauss et al., 2006). The *Vassiliou Mathematics Proficiency Foundation Phase Test* (grades 1-3) and the *Vassiliou Mathematics Proficiency Test* (grades 4-6) were created in the years 2000 and 2003 respectively. This means that both these tests are close to the end of their lifespan. Also important to note is that since the creation of the tests the national primary school curriculum has undergone many changes. Since the test items are based on what the curriculum expects from learners in the various grades these may not be applicable today. The foundation phase test was created and normed using a sample from the Free State region who's home language was English (Vassiliou, 2000). These learners all attended English medium schools (Vassiliou, 2000). As previously stated English medium schools are seen as schools for the upper and middle class and as such are viewed as having a more superior quality of education than those in the townships (Reddy, 2005; Spaull, 2012; van der Berg, 2008). This places learners in the township schools who received a much more inferior quality of ecudation at a disadvantage when taking this test.

6.2 RECOMMENDATIONS

The first recommendation is that the towns surrounding Grahamstown be included in the study for reasons listed above.

Secondly, collection of data could be done on the same learners in all four school terms to make the norms more applicable at any time of the year.

Thirdly, a more formal way of assessing the socioeconomic status is needed, this will help with judging the effect that the SES has on the learner's education.

Lastly, before further testing, the test items need to be reviewed. This could be done by either comparing them to the outcomes of the current curriculum, or a similar process followed by Vassiliou could be followed- this means giving the test to teachers from different types of schools in different regions and have them review the test items.

6.3 FINAL SUMMARY

Norms form an integral part of assessments, moreso when it comes to intepretation of results and diagnosis. Norms take into consideration the demographic variables in a learner or testee's life. These demographics include race, age, gender and closely related to this study socioeconomic status, quality of education and geographical location. My study has made links between these last three variables and the mathematics performance of learners on an international and local level. The Eastern Cape is known for its high poverty rates and poor quality of education as evident in the ANA results. These largely stem from the previous oppressive system which diresgarded the black learner's education.

The VASSI, the subject of this research, was created and normed using a standardisation sample from the Free State. The current norms of the VASSI are what Shuttleworth-edwards (2016) and colleagues refer to as population based or country-wide norms. From this it was clear that norms according to geographical location were necessary.

This study has provided clinically useful norms for the *Vasilliou Mathematics Proficiency Foundation Phase Test* and *Vasilliou Mathematics Proficiency Test*, stratified for the disadvantaged learners of the peri-urban areas of the Eastern Cape. Further research is needed to refine the data and address the limitations of this study as these norms are merely a subset which can only be applied to a specific group of learners.

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Vassiliou, C. (2003). *VASSI Mathematics Proficiency Test.* Bloemfontein, South Africa.

APPENDICES

Appendix A: Permission to undertake study from EC Department of Education

Province of the
EASTERN CAPE
EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape • Private Bag X0032 • Bhisho 5605 • REPUBLIC OF SOUTH AFRICA
Website: www.ecdoe.gov.za • Email babalwa.pamla@edu.ecprov.gov.za
Enquiries: B Pamla

Tel : +27 (0)40 608 4773/4035/4537 •
Fax: +27 (0)40 608 4574

04 September 2014

Mr. Sizwe Zondo
Department of Psychology
P.O. Box 94
Grahamstown
5099

Dear Mr. S Zondo

PERMISSION TO UNDERTAKE AN INDEPENDENT STUDY INVOLVING HONOURS STUDENTS: PSYCHOMETRIC NORMING OF MATHEMATCIS PROFICIENCY OF XHOSA SPEAKING CHILDREN IN THE EASTERN CAPE

1. Thank you for your application to conduct research.

2. Your application to conduct the above mentioned research in 3 Primary Schools under the jurisdiction of Grahamstown District of the Eastern Cape Department of Education (ECDoE) is hereby approved on condition that:

    a. there will be no financial implications for the Department;

    b. institutions and respondents must not be identifiable in any way from the results of the investigation;

    c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;

    d. you will make all the arrangements concerning your research;

    e. the research may not be conducted during official contact time, as educators' programmes should not be interrupted;

    f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

    g. the research may not be conducted during the fourth school term, except in cases where a special well motivated request is received;

EASTERN CAPE

building blocks for growth

Page 1 of 2

h. your research will be limited to those schools or institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

i. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.

j. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

k. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

l. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

m. you comply with your ethical undertaking (commitment form).

n. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation.

3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

4. The Department will publish the completed Research on its website.

5. The Department wishes you well in your undertaking. You can contact the Chief Director, Mr. GF Mac Master on the numbers indicated in the letterhead or email greg.macmaster@edu.ecprov.gov.za should you need any assistance.

GF MACMASTER
CHIEF DIRECTOR: STRATEGIC MANAGEMENT MONITORING AND EVALUATION
FOR SUPERINTENDENT-GENERAL: EDUCATION

Appendix B: Rhodes University Ethical Committee Approval Letter

RHODES UNIVERSITY
Where leaders learn

Rhodes University Ethical Standards Committee, Rhodes University, P O Box 94, Grahamstown, 6140 Tel: +27 46 603 7366 . Fax: +27 46 603 8934 . Email: ethics-committee@ru.ac.za

17-Jun-2015

Dear Mr Jan Knoetze

Ethics Clearance: Norming the VASSI mathematics proficiency test with isiXhosa learners

Principal Investigator: Mr Jan Knoetze

This letter confirms that a research proposal with tracking number: RU- HSD-15-06 -0004 and title:

Norming the VASSI mathematics proficiency test with isiXhosa learners was given ethics clearance by the Rhodes University Ethical Standards Committee.

The consent letter for parents could state the possible uses and benefits of the research - in other words how will the findings be used and how might it contribute towards the educational interests of the community/schools/ learners more broadly.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether or not the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Yours Sincerely,

Professor M. Goebel: Chairperson RUESC.

Note:

1. This clearance is valid from the date on this letter to the time of completion of data collection.
2. The ethics committee cannot grant retrospective ethics clearance.
3. Progress reports should be submitted annually unless otherwise specified.

Appendix C: IsiXhosa parent informed consent form

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

ISEBE LESAYIKHOLOJI • Tel: (046) 603 8500/ 8344 • Fax: (046) 622 4032 • e-mail: j.knoetze@ru.ac.za

Mzali Obekekileyo

UVAVANYO LWEZIBALO

Igama lam nguSiphesihle, ndingu gqirhawenqondo (clinical psychologist) eFort England Hospital. Ndenza umsebenzi wokuvavanya iingqondo zabantwana. Xa ndisenza umsebenziwam kubalulekile ukuba iziphumo zoluvavanyo zithelekiswe kumgangatho ofanelekileyo xakujongwa apho umntwana afundakhona, ahlalakhona, ulwimi aluthethayo kunye neminyaka yakhe. Lomgangatho kuthiwa ziiNorms. Imivavanyo okanye iitest ezininzi apha eMzantsi Afrika zisebenzisa iinorms zaseMelika, ngoko kufanele ukuba kwenziwe iinorms zalapha eMzantsi Afrika. Nalapha eMzantsi Afrika asikwazi uthi umntwana efunda elokishini sithelekise iizikora zakhe nezomntwana ofunda etown kuba izikolo azifani.

Umsebenzi wam kukuqokelela izikora zezibalo zabantwana abafunda kumabanga asezantsi kwizikolo zaselokishini eRhini. Ezizikora ndizakuzisebenzisa elwakhiweni lwezi Norms. Oluvavanyo okanye le test yezibalo ndizakuyisebenzisa isekwe yisilabhasi yezikolo zonke zase Mzantsi Afrika yaye iyafana neminye imisebenzi yesikolo. Ithi lonto akukho monakalo, nabungozi obuza ngasemntwaneni. Isicwangciso sexesha nemini sizakwenziwa nenqununu kunye nootitshala besikolo. Oluvavanyo aludingi gama lomntwana ngoko ke iziphumo nezikora azizokuhlonyelwa kwigama lomntwana.

Akukho mntwana uzakunyanzeliswa ukuba athathe inxaxheba koluvavanyo, kodwa uncedo lo mntwana luyadingeka ekukwenzeni ezinorms. Umphathiwam nomntu ondongamelayo nguMnumzana Jan Knoetze, unozazi-ngqondo kwezemfundo. Ukuba unemibuzo okanye kukho into engakucacelanga ungaqhagamshelana noMnu. Knoetze ku j.knoetze@ru.ac.za okanye kwezinombolo zilandelayo. Imvume yokwenza leprojekthi ifunyenwe kwiSebe lwezeMfundo yePhondo eBhisho kwakunye nakummandla weofisi yaseMakana.

Ndibulela kuni bazali, kootitshala kwakunye nakwinqununu yesikolo.

Nceda, zalisa le fomu ingezantsi uyiphindisele esikolweni msinya.

Enkosi

✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂✂

NCEDA PHAWULA NGE(√) ENYE YEZI ZILANDELAYO:

☐

Ndinikela imvume yokuba umtwanawam athathe inxaxheba kuleprojekthi.

☐ ***Andivumi ukuba umntwanawam athathe inxaxheba kuleprojekthi.***

Igama nefani yomntwana: ______________________

Igama nefani yomzali: _______________________

Utyikityo: _________________________ ***uMhla:***____________________________

Appendix D: Original VASSI Grade 1 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE
ANSWER SHEET: GRADE 1

Name of Learner: .... Gender (m/f): ....

Date: .... Age: ....

1.) 10 + 5 = __________ ___

2.) 14 ; 15 ; ___ ; 17 ; 18 ; 19 ___

3.) Half of 8 = __________ ___

4.) 5 x 2 = __________ ___

5.) R2 + R1 + R5 + R5 = R__________ ___

6.) 16 ; 18 ; ___ ; 22 ; 24 ; 26 ___

7.) John has 6 blocks. Pat has 5 blocks. Ben has 4 blocks. How many blocks do they have altogether? __________ ___

8.) I share 12 sweets between 2 children. How many sweets will each child have? __________ ___

9.) Pat has 9 sweets. She eats 6 sweets. How many sweets are left? __________ ___

10.) 16 ÷ 2 = __________ ___

11.) 4 cats have __________ legs. ___

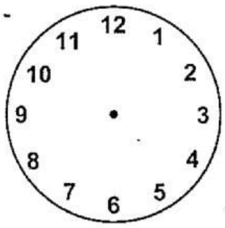
12.) Kabelo had 11 marbles. He lost 5 and later found 2. How many did he have then? __________ ___

13.) 3 x 4 = __________ ___

14.) Meg had 13 eggs. She lost 4 eggs and the fox took 3 eggs. How many eggs does Meg have now? __________ ___

15.) **18 ; 21 ; ___ ; 27 ; 30 ; 33** ___

16.) **Draw the hands to show the time on the clock.**



Half past 8 ___

17.) **18 ÷ 3 = __________** ___

18.) **Anne picks 16 roses. She shares them among her 4 friends. How many roses do they each get? __________** ___

19.) **Half of 7 = __________** ___

20.) **Double $5\ ^1/_2$ = _________** ___

RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix E: Translated VASSI Grade 1 Test

VASSI-X

ANSWER SHEET: GRADE 1

3.Isiqingatha Sika 8 = __________ **Translation Half of 8**

7. UJohn unebloko ezi- 6.Ezika pat zi – 5. UBen unee bloko ezi – 4. Zingaphi ibloko zabo xa zidibene zonke? ____________ **Translation: John has 6 blocks, Pat has 5 and Ben has 4, how many blocks do they have all together?**

8. Ndohlulela abantwana aba – 2 ilekese ezili – 12 ngokulinganayo. Emnye kubo uyakufumana zibe ngaphi? _____________**Translation: If I am dividing 12 sweets equally between 2 children, how many will each receive?**

9. UPat uneelekese ezili – 9. Utya azi – 6. Zingaphi iilekese eziseleyo zingaphi? __________ **Translation: Pat has 9 sweets; he eats 6, how many sweets are left?**

11. iikati ezi – 4 zinemilenze emingaphi? __________**Translation: How many legs do 4 cats have?**

12. UKabelo unamapetyu ali – 11. Ulahle ama – 5 wabuye wafumana aba 2. Mangaphi amapetyu ache ngoku? ___________**Translation: Kabelo has 11 marbles, he lost 5 then found 2, how many marbles does he have now?**

14. UMeg ebenamaqanda ayi – 13. Ulahle amayi -4 yaze inja yathatha amayi 3. UMeg unamaqanda amangaphi ngoku? __________ **Translation: Meg had 13 eggs, she lost 4 and the dog took 3. How many eggs does she now have?**

16. Fakela iimpondo/izandla kule woshi ukobonakalisa eli xesha, icala emva kwentsimbi yesi – 8. **Translation: Put hands on this watch to show this time: half past 8**

18. UAnne ukha iirozi (iintyamtyambo) ezili – 16. Uklulelene ngazo netshomi zakhe ezi – 4. Emnye kubo ufumene iintyamtyambo ezingaphi? ______________**Translation: Anne picks 16 roses and shares them equally with four of her friends, how many do each of them get?**

19. Isiqingatha (ihafu) sika – 7. ________________**Translation: half of 7**

20. Phinda-phinda u 5½ kabini. ___________ **Translation: Multiply 5½ twice**

Appendix F: Original VASSI Grade 2 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE
ANSWER SHEET: GRADE 2

Name of Learner: .... **Gender (m/f):** ....

Date: .... **Age:** ....

1.) **Vusi has 15 marbles. He loses 8. How many marbles are left? __________** —

2.) **Arrange the following numbers from biggest to smallest**
98 ; 67 ; 101 ; 24 ; 50 ; 19 ; 91 ; 15
___ ; ___ ; ___ ; ___ ; ___ ; ___ ; ___ ; ___ . —

3.) **Arrange the following numbers from smallest to biggest**
11 ; 56 ; 29 ; 9 ; 44 ; 14 ; 87 ; 78
___ ; ___ ; ___ ; ___ ; ___ ; ___ ; ___ ; ___ . —

4.) **Sipho, Lindy, Sara, Marcus, Ester, Jane, John and Mandla each have R5. How much money do they have altogether? __________** —

5.) How many minutes are there in an hour?

___________ ___

6.) 46 + 63 = ___________ ___

7.) How many hours are there in a day? ___________ ___

8.) 72 – 60 = ___________ ___

9.) Half of 49 = ___________ ___

10.) ___ ; ___ ; 105 ; 110 ; 115. ___

11.) The two numbers before 48 are ___ and ___. ___

12.) 350 ; 300 ; 250 ; ___ ; ___ ; ___ . ___

13.) How many 20c pieces are there in R2?

___________ ___

14.) Granny bakes 36 cookies. She shares them among 3 children. How many cookies does each child get? __________ __

15.) One fly has 6 legs. How many legs would 8 flies have? __________ __

16.) Double 75 = __________ __

17.) 30 ; 45 ; 60 ; ___ ; ___ ; ___ . __

18.) In a shop there are 25 red balloons and 28 blue balloons. If 19 of the balloons pop, how many balloons are left? __________ __

19.) Double 9 $^{1}/_{4}$ = __________ __

20.) 54 x 3 = __________ __

RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix G: Translated VASSI Grade 2 Test

VASSIX Gr2

ANSWER SHEET: GRADE 2

1. UVusi unamabhastile (amapetyu) ali – 15. Ulahlekelwe ngasi – 8. Ushiyeke namangaphi? ____________ **Translation: Vusi has 15 marbles, he loses 8, how many does he have left/**

2. Landelelanisa la manani ukusuka kwelikhulu kuye kwelincinci. ___; ____; ___; ___; ___; ____; ____; ____.

3. Landelelanisa la manani ukusuka kwelincinci kuye kwelikhulu. ____; ____; ____; ____; ____; ____; ____; ____.

4. USipho, uLindy, uSara, uMarcus, uEster, uJane, uJohn no Mandla bane R5 umntu emnye. Yimali ni xa beyidibanisile iyonke? _________ **Translation: Sipho, Lindy, Sara, Marcus, Ester, Jane,John and Mandla each have R5, How much money would they have combined?**

5. Mingaphi imizuzu I awari enye? ______________ **Translation: How many minutes in 1 hour?**

7. Zingaphi iiawari zosuku? ______________**Translation: how many minutes in the hours if the day?**

9. Isiqingatha sama – 49. _________ **Translation: half of 49**

11. Amanani amabini phambi kuka 48 ngu _______ no _________. **Translation: two numbers before 48 are**

13. Zingaphi ii 20c kwi R2? __________ **Translation: how many 20c coins make up R2?**

14. UGogo ubhake ii kuku ezingama – 36. Uzohlulele abantwana abathathu. Emnye umntwana uyakufumana zibengaphi? _______**Translation: Grandma baked 36 cakes and divided them between 3 children. How many will each receive?**

15. Impukane enye inemilenze emi – 6. Imilenze yeempukane ezisi – 8 mingaphi? ________

16. Phinda-phinda u 75 kabini. __________ **Translation: one fly has 6 legs, how many legs would 8 flies have?**

18. Evenkileni kukho iibhaloni ezibomvu ezingama 25 nezi ngama 28 eziblue. Uba ezili – 19 zigqabhukile kusele iibhaloni ezingaphi? __________ **Translation: there are 25 red ballons at the shop, 28 blue, if 19 of them burst, how many would be left?**

19. Phinda-phinda u 9¼ kabini. _____________ **Translation: 9¼ X 9¼**

Appendix H: Original VASSI Grade 3 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE

ANSWER SHEET: GRADE 3

Name of Learner: .... Gender (m/f): ....

Date: .... Age: ....

1.) Half of 100 = ___________ | ___

2.) Count 101 ; 106 ; ___ ; ___ ; ___ ; ___ . | ___

3.) 27 x 5 = ___________ | ___

4.) Half of 241 = ___________ | ___

5.) (110 ÷ 10) – 7 = ___________ | ___

6.) If I walk 12 km each day for a week, how far do I walk? ___________ | ___

7.) (27 ÷ 3) + 5 = ___________ | ___

8.) $\frac{1}{4}$ hour + $\frac{1}{2}$ hour + 15 minutes = __________

9.) 96 ÷ 4 = __________

10.) 2 ; 4 ; 8 ; ___ ; 32 ; ___ .

11.) 1500 x 5 = __________

12.) 571 – 348 = __________

13.) I have 76 kg of sweets to sell. I want to pack them into packets each weighing 4 kg. How many packets of sweets can I make? __________

14.) What fraction of the shape is shaded and what fraction unshaded?

__________ Shaded

__________ Unshaded

15.) I have 3 fifty cent coins, 2 twenty cent coins, 2 ten cent coins, 1 five cent coin and 4 one cent coins in my purse. How much money do I have altogether? __________ __

16.) Susan has 47 drinking straws. She needs 72 straws. How many straws does she still need?

__________ __

17.) If the perimeter of a square is 24 cm, what is the measurement of each side? __________ __

18.) My watch is 10 minutes slow. If it shows ten past ten, what is the correct time? __________ __

19.) $^{1}/_{5}$ of 350 = __________ __

20.) A family uses 21 kg of sugar every two months. How many kilograms of sugar will the family use in 8 months? __________ __

RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix I: Translated VASSI Grade 3 Test

VASSIX Gr3

ANSWER SHEET: GRADE 3

1. I hafu/isiqingatha sika – 100 = ___________ **Translation: half of 100**

2. Bala 101; 106; ____; ____; ____; ____.**Translation: write 101,106**

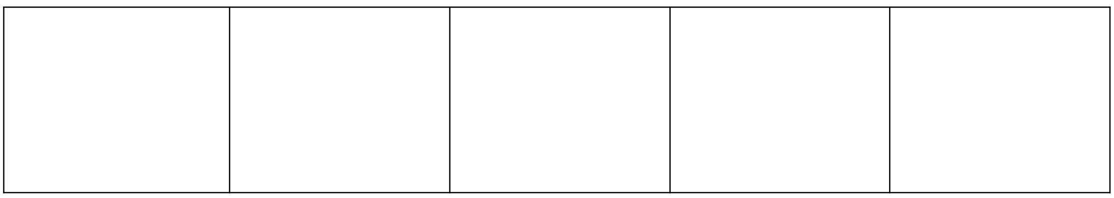
4. Isiqingatha sama 241 = ____________**Translation: half of 241**

6. Ndihamba ii kilomita ezili – 12 ngosuku ngalunye lweveki, zingaphi iikilomita endizihambileyo ngeveki? __________**Translation: I travel 12km a day, for each day of the week, how many kilometres will i have travelled at the end of each day?**

8. ¼ (ye awari) + ½ (ye awari) = 15 imizuzu = ___________

13. Ndina 75kg yeswiti endizithengisayo. Ndifuna ukuzifaka kwipakethi ezinobunzima ubuyi – 4kg inye. Ziyakuba ngaphi ezipakethi? __________________ **Translation: I have 75kg worth of sweets to sell, I want to put them in packet that can only accommodate 4kg each, how many bags do I need?**

14. Leliphi iqhezu (fraction) lalomzobo elife mnyama neli lingenziwanga nto? **Translation: what fraction of this drawing is coloured in and what fraction isn't?**



_________________ - elife mnyama. **Translation: coloured in**

_________________ - elingenziwanga mnyama. **Translation: not coloured in**

15. Ndine 50c ezi ntathu, ii 20c ezimbini, ne 10c ezimbini, ne 5c enye, nee 1c ezine esipajini sam. Ndinamali ni xa iyonke? _________**Translation: I have 3 50c coins, 2 10c coins, 1 5c coin and 4 1c coins in my wallet. How much do I have altogether?**

16. USusan unezistraws zokusela ezingama 47. Ufuna zibengama 72. Ushota ngezistraws ezingaphi? ________________ **Susan has 47 straws, she wants to have 72 straws, how many straws is she short of?**

17. (Perimitha) weskwere yi 24cm, ubude becala ngalinye uthini? ____________**Translation: If the perimeter of a square is 24cm, what is the length of each side?**

18. Iwoshi yam icotha ngemizuzu eli – 10. Ukuba ibonisa ixesha eliyimizuzu elishumi emva kwentsimbi ye shumi ngubani ixesha elichanekileyo? ___________**Translation: My watch is 10min behind, If it shows the time to be 10min after 10, what is the actual correct time?**

19. ⅕ ka 350 = _____ **Translation: ⅕ of 350 =_**

20. Usapho lusebenzisa ama 21kg eswekile ngenyanga ezimbini. Zingaphi ii kilogram zeswekile eziya kusetyenziswa lolu sapho ngenyanga ezisi – 8? ____________**Translation: If a family uses 21kg worth of sugar over a period of two months, How many kilograms worth of sugar will this family use over a period of 8 months?**

Appendix J: Original VASSI Grade 4 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE

ANSWER SHEET: GRADE 4

Name of Learner: .... Gender (m/f): ....

Date: .... Age: ....

1.) Fill in < or = or > :

37 - 26 ____________ (15 + 9) ÷ 6 __

2.) Round off 347 to the nearest 100 ________________ __

3.) What is the difference between the biggest and smallest numbers in this group of numbers:

74 ; 47 ; 88 ; 57 ; 38 ; 83 ________________ __

4.) Half of 525 = ____________ __

5.) 0,3 + ____________ = 1 __

6.) 250 g + $^1/_4$ kg = _______ g __

7.) Complete the pattern: □ ; ◆ ; □ ; ◇ ; ___ ; ◆ ; ___ . __

8.) **Complete the pattern: ←; ↑ ; → ; ↓ ; ←; ___ ; ___ .** ___

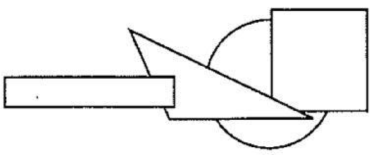
9.) **Identify each of the following shapes and write the name in the space provided:**

___________ ___________ ___________ ___________ ___

10.) **Which shape below is two-dimensional and which is three-dimensional? Fill in 2-D for two-dimensional and 3-D for three-dimensional in the space provided.**

 ______ ______ ___

In the figure below there are two-dimensional shapes packed onto one another.



11.) **Which shape lies on top?** ____________________ ___

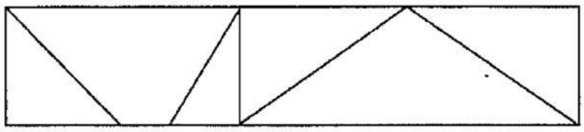
12.) **Which shape lies at the bottom?** ________________ ___

13.) Underline two of the shapes below, which, when put together, will form a square.

a.  b.  c.  d.  ___

14.) How many triangles are there in the figure below?

______________________________ ___



Fill in < or = or > :

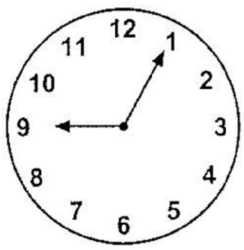
15.) 13 months ______ 1 year ___

Fill in < or = or > :

16.) 225c ______ R1.60 ___

17.) How many days in a leap year? ________________ ___

18.) What was the time 10 minutes earlier? ____________ ___



Study the table and then answer the questions that follow.
*** means that the sport is offered on that day.**

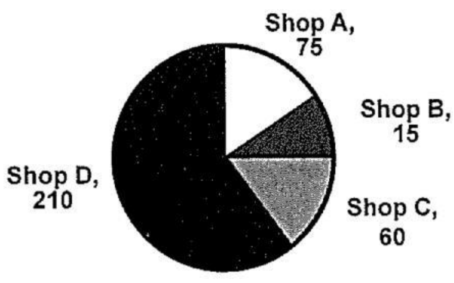
	Monday	Tuesday	Wednesday	Thursday	Friday
Netball		*	*		
Swimming	*		*		*
Gymnastics		*		*	
Athletics		*		*	*
Choir practice	*				*

19.) Which activities are not offered on Friday?

____

Study the pie chart below: The numbers indicate the number of workers per shop.

20.) If each worker is paid the same salary, which shop spends the most money on salaries? __________



RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix K: Translated VASSI Grade 4 Test

VASSIX Gr4

ANSWER SHEET: GRADE 4

1. Fakela < okanye = okanye >:

37 – 26 ___________ (15 + 9) ÷ 6.

Translation: Insert <, = or >: 37 – 26 ___________ (15+9) ÷ 6.

2. Sondeza ama – 347 kelona khulu (100) likufutshane. ________

Translation: Put 347 to the nearest hundred (100)

3. Yintoni umahluko phakathi kwelona nani likhulu nakwelona lincinci kweli qela lamanani? ___________________

Translation: What is the difference between the highest and the lowest number out of the following numbers?

4. Isiqingatha sika 525 = ____________

Translation: The halve of 525 =

7. Gqibezela ipateni:

Translation: complete the pattern

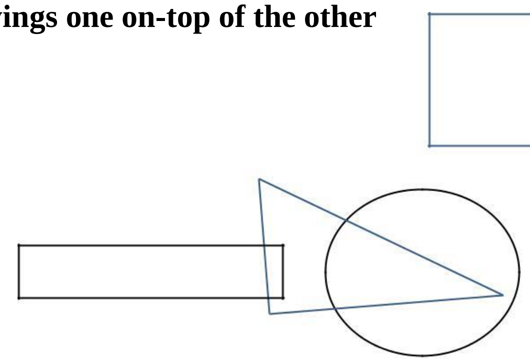
8. Gqibezela ipateni:

Translation: complete the pattern

9. Qwalasela le mizobo ze ubhale igama lomzobo ngamnye kumgca ongaphantsi kwawo.
Translation: Observe the following drawings/shapes and then give the name of each on the line underneath

_______________ _______________ _______________ _______________

10. Kulo mzabo ungaphantsi kunemizobo engo 2- dimenshinal ebekweomnye ngaphezulu komnye: **Translation: In the diagram underneath there are 2 –dimensional drawings one on-top of the other**



11. Yiyiphi ishape ephezu kwazo zonke? ____________

Translation: Which shape is on top of all the others?

12. Yiyiphi ishape engaphantsi kwazo zonke? _____________

Translation: Which shape is underneath all the others?

13. Krwela umgca ngaphantsi kwemizobo emibini enokuthi xa yenza iskwere **Translation: Draw a line underneath two drawings which would follow this order when forming a square**

a. b. c. d.

14. Bangaphi oonxa ntathu abakulo mzobo ungaphantsi? _____________ **Translation: How many triangles are in the drawing underneath?**

Fakela u <, oknaye u =, okanye u >: **Translation: Insert <,= or >**

15. Iinyanga ezili – 13 _____________ unyaka omnye**: Translation: 13 months is _____________ one year**

Fakela u <, oknaye u =, okanye u >: **Translation: Insert <,= or >**

16. 225c __________ R1.60**: Translation:225c __________ R1.60**

17. Zingaphi iintsuku zonyaka oyi leap year? __________ **Translation: How many days are in a leap year?**

18. Ibingubani ixesha kwimizuzu eli – 10 edlulileyo? ______________ **Translation: What was the time 10 minutes ago?**

Jongisisa esi sicwangciso silandelayo ze upendule imibuzo. Uphawu u * luthetha ukuthi umdlalo

udlalwa ngolo suku.

	Mvulo	Lwesibini	Lwesithathu	Lwesine	Lwesihlanu
Inetball		*	*		
Ukuqubha	*		*		*
Imithambo		*		*	
Ukubaleka		*		*	*
Ikwayara	*				*

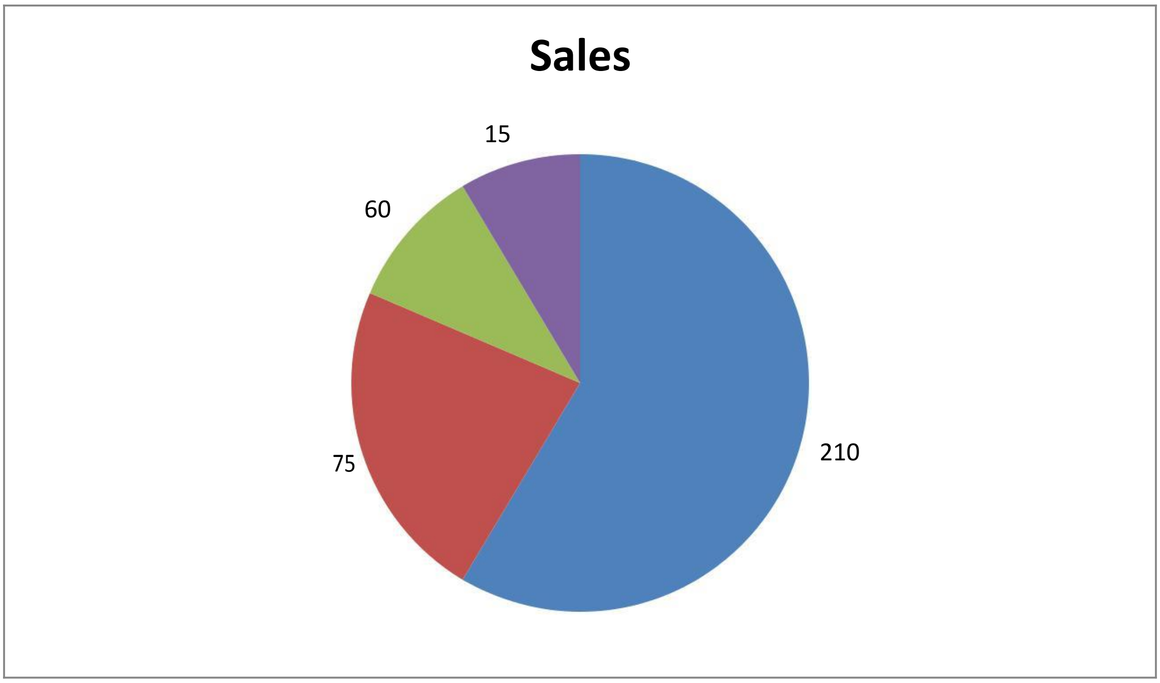
Translation: Look at the diagram and answer the following questions. The symbol * means the game is played on this day.

	Monday	Tuesday	Wednesday	Thursday	Friday
Netball		*	*		
Swimming	*		*		*
Imithambo		*		*	
Athletics		*		*	*
Choir	*				*

19. Yiyiphi imidlalo engekhoyo ngolwesihlanu? _________________ **Translation: Which of these games do not feature on Friday?**

Qwalasela le pie chart ingezantsi: Amanani axela/amele inani labasebenzi bevenkile nganye. Translation: Observe the pie chart below: each number represents the number of people working at each store

20. Ukuba bonke abasebenzi babhatalwa ngokulinganayo, yiyiphi eyona venkile ehlawula imali eninzi yabasebenzi? **Translation: If all the workers earn the same amount of money, which store uses the most amount of money to pay its workers?**



Appendix L: Original VASSI Grade 5 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE

ANSWER SHEET: GRADE 5

Name of Learner: .... Gender (m/f): ....

Date: .... Age: ....

1.) Write from biggest to smallest:

0,007 ; 7 ; 0,07 ; 70 ; 0,7

______ ; ______ ; ______ ; ______ ; ______ . __

2.) (6348 + 3481) - (1368 + 843) = ____________

________________________ __

3.) 321 can be witten as 300 + 20 + 1. Write 23504 in the same way ____________

________________________ __

4.) $^1/_2 + 1^1/_4 =$ ____________ __

5.) Write $^{29}/_7$ as a mixed number ____________ __

6.) Arrange the numbers 2 ; 3 ; 5 and 7 in the boxes below to make the equation true.

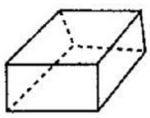
$\boxed{} \times \boxed{} + \boxed{} - \boxed{} = 24$ __

7.) Complete the pattern: $^{35}/_{100}$; $^{30}/_{100}$; ______ ; ______. | __

8.) Complete the pattern: ↑ ; ↓ ; → ; ↑ ; __ ; __ ; __. | __

9.) Underline the answer below that is not an example of a quadrilataral.

a. square b. rectangle c. kite d. triangle | __

10.) 

Is the above shape 2-dimensional or 3-dimensional?

____________________ | __

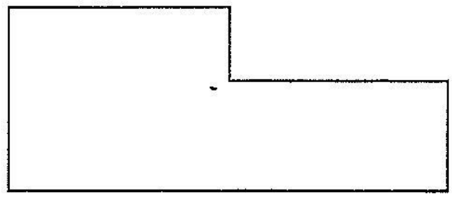
11.) You need 20 fishcakes. Will you buy a large box of 20 fishcakes for R15,40 or two small boxes of 10 fishcakes for R7,50 each?

____ | __

12.) A motorist travels at an average speed of 110 km per hour. How far will he travel if he travels for 4 hours?

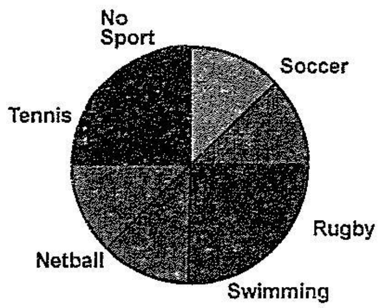
________________________ km | __

13.) With your ruler, measure the perimeter of the figure below: _________ cm



14.) 1,436 kg + 3,447 kg + 32 kg = _______________ kg

In the grade 5 class there are 40 children (The pie chart is divided into 8 equal pieces).



15.) What *fraction* of the class plays netball?

____

16.) How many children do *not* take part in sport?

____

Warren, Fezile and Rory all take part in the Southern Gymnastics Competition. The scoreboard looks like this after the first three events:

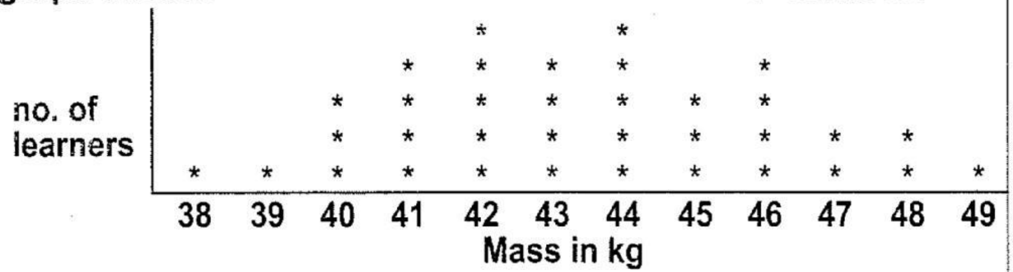
Names	Event 1	Event 2	Event 3	Total Score
Warren	8,20	7,15	7,55	22,9
Fezile	8,20	8,50	9,55	26,25
Rory	7,55	8,70	4,50	20,75

17.) Who had the lowest score in a single event?

______________________ ___

18.) What is the difference between Fezile's total score and Rory's total score? ______________________ ___

The number of learners with a specific mass is given in the graph below: * = 5 children



19.) How many learners have a mass of 42 kg?

______________________ ___

20.) How many learners are there altogether? __________ ___

RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix M: Translated VASSI Grade 5 Test

VASSIX Gr5

ANSWER SHEET: GRADE 5

1. Bhala ukusuka kwelona nani llkhulu uye kwelincinane: **Translation: write down the smallest number to the biggest**

   ____________; _______________; ______________; _______________

3. U 321 angabhalwa ngolu hlobo: 300 + 20 + 1.**Translation 321 can be written as 300+20+1** Bhala u 23504 ngolo hlobo. **Translation: do the same for 23504**

   ____

5. Bhala u 27/9 nje ngenani elixubeneyo ___________

6. Faka la manani: 2 ; 3 ; 5 ; no 7 kweziblokisi ukenza le ikheyishion ibe yinyani.

   = $\square$ x $\square$ + $\square$ - $\square$ 24

7. Gqibezela ipateni:

8. Gqibezela ipateni: ↑; ↓ ; → ; ↑ ; _______ ; ________ ; _________ .

9. Krwela umgca ngaphantsi kwedulo engasinguwo umzekelo we khwadrilateral.

   a. isikwere b. uzande c. ikayiti d. unxantathu

10. Ngaba lo mzobo ungentla yi 2 – dayimenshinali okanye yi 3 – dayimenshinal?

11. Ufuna iifishkeyiki ezingama – 20. Ungathenga eziphi kukho ibhokisis yebkulu yefishkeyiki ezingama – 20 nge R15.40 okanye iibhokisana ezimbini, ezincinge, inye ineefishkeyiki ezili 10 inye nge R7.50 ibhokisana?

12. Umqhubi wemoto uqhuba ngesantya se 110km nge yure. Uyakuqhuba ikilomita ezingaphi ukuba uhamba lwakhe lumtathe iyure ezi 4?

13. Nge rula yakho linganisa umjekelo walomzobo ungezantsi:

14. Kwibanga lesi 5 kukho abantwana abangama 40. (Lo mzobo wepayitshati uhlula-hlula kayi 8, amaceba alinganayo.)

15. Yeyiphi ifrakshini yeklasi edlala ibhola yomnyazi? _______________

16. Bangaphi abantwana abangadlali sport? ________________

UWarren, Fezile no Rory bonke bathabatha inxaxhebo kukhuphiswano lwe Southern Gymnastics. Emva

Kwemidlalo emithathu amanqaku ebhodini ami ngoluhlobo.

Amagama	Umdlalo 1	Umdlalo 2	Umdlalo 3	Amanqaku ewonke
Warren				
Fezile				
Rory				

17. Ngubani ozuze owona manqaku aphantsi kumdlalo omnye? ______________

18. Uthini umahluko phakathi kwamanqaku ewonke kaFezile naka Rory ewonke? ________________

Inani labafundi nobunzima (mass) zinikwe kule grafu ingezantsi:

U * umele abantwana abahlanu

Inani labafundi

19. Bangaphi abafundi abanobunzima obungama – 42kg? _______________

20. Bangaphi abafundi xa bebonke? _________________

Appendix N: Original VASSI Grade 6 Test

VASSI MATHEMATICS
PROFICIENCY TEST
INTERMEDIATE-PHASE

ANSWER SHEET: GRADE 6

Name of Learner: .... Gender (m/f): ....

Date: .... Age: ....

1.) 10^3 = (underline the correct answer)

a) 30 b) 1000 c) 300 d) 100 ___

2.) 9,2 - 5,786 = ________________ ___

3.) Circle all the factors of 12:

1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; 10 ; 11 ; 12 ___

4.) Double 124,7 = __________ ___

5.) Write $^{120}/_{25}$ in its simplest form ________________ ___

6.) Simplify: $3\,^1/_2 + 4\,^1/_3 - 5\,^5/_6$ = __________ ___

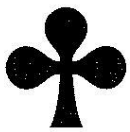
7.) If $^1/_3$ of 24 = $^1/_4$ of y, then y = __________ ___

8.) Complete the pattern: 3 ; 6 ; 12 ; 24 ; ____ ; ____

9.) Complete the pattern: 0,6 ; 1,2 ; 1,8 ; ____ ; ____

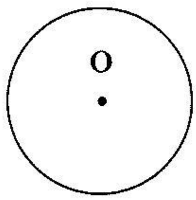
10.) Complete the pattern: 2 ; 3 ; 5 ; 8 ; ____ ; ____

11.) Draw 1 line of symmetry through the shape.

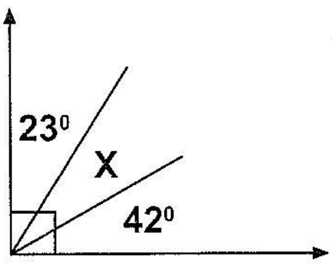


12.) O is the centre of the circle. Measure the diameter:

____________________ cm

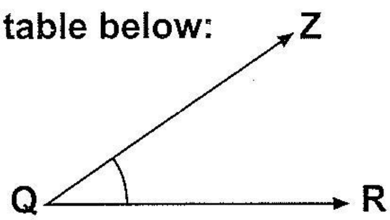


13.)



X = ________________ ^{0}

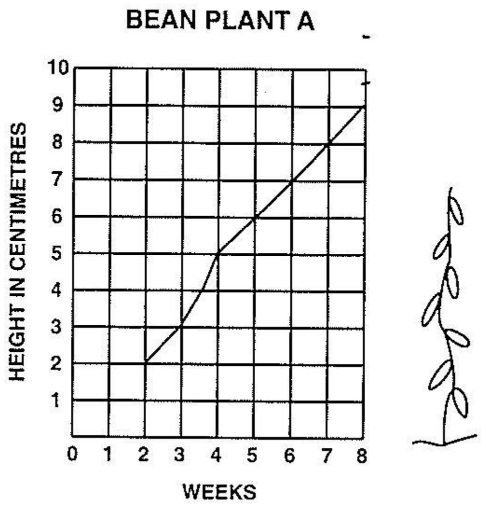
Complete the table below:

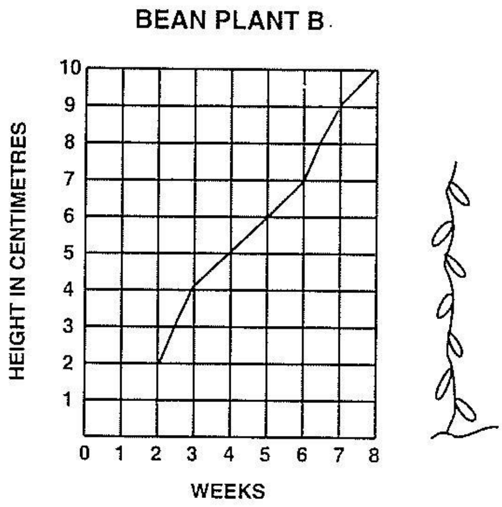


Angle	Type of angle (acute, obtuse, right angle)	Degrees
ZQR	14.)	15.)

Mrs Gardener compares two kinds of climbing beans (refer to the graphs below):

16.) Which bean plant grows the fastest between weeks 2 and 3? __________________





A survey was done to determine the type of transport the learners use to go to school. The table below shows the number of learners that use the various transport systems.

Type of Transport	Number of learners
Motor Car	~~IIII~~ ~~IIII~~ ~~IIII~~ II
Bicycle	~~IIII~~ I
Taxi	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
Bus	~~IIII~~ ~~IIII~~ III
Walk	II

17.) How many learners took part in the survey?

____

Khani is researching her family history. She has collected the following information:

NAME	GENDER	DATE BORN	DATE DIED
Dreyer, Noel	Male	1867-04-13	1914-12-27
Solomon, Gladys	Female	1845-07-10	1901-06-01
Koen, Maria	Female	1899-05-11	1899-05-11
Swart, Estelle	Female	1903-01-01	1959-01-17
Samuels, Johanna	Female	1899-05-12	1956-08-19
Koen, Petrus	Male	1904-09-13	1983-03-31
May, Constance	Female	1936-08-27	1958-05-30
Cilliers, Morris	Male	1938-10-26	1999-07-29
Koen, Gerty	Female	1903-04-17	1990-07-31
Els, Willem	Male	1891-03-17	1963-09-12

18.) Who was born first?

_______________________________________ __

19.) At what age did Estelle Swart die?

_______________________________________ __

20.) Who died at the youngest age?

_______________________________________ __

RAW SCORE	STANINE	PERCENTILE RANK
/ 20		

Appendix O: Translated VASSI Grade 6 Test

VASSIX Gr5

ANSWER SHEET: GRADE 6

1. 10^3 = (Krwela umgca phantsi kevempendulo echanekileyo)

   a) 30 b) 1000 c) 300 d) 100

3. Yenza isangqa kuzo zonke iifekta zika – 12:

   1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9 ; 10 ; 11 ; 12

4. Phinda phinda kabini u 124,7 = ________________

5. Bhala u 120/25 ngeyona ndlela ilula __________________
6. Yenza lula: $3\frac{1}{2} + 4\frac{1}{3} - 5\frac{5}{6}$ = ___________

7. Ukuba i $\frac{1}{3}$ yama 24 = $\frac{1}{4}$ ka y; ngoko u – y = ________________

8. Gqibezela ipateni: 3 ; 6 ; 12; 24 ; _____ ; _____

9. Gqibezela ipateni: 0,6 ; 1,2 ;1,8 ; _____ ; _____

10. Gqibezela ipateni: 2 ; 3 ; 5 ; 8 ; ____ ; ____

11. Zoba umgca ubemnye obonisa ulingano macala kulo mfanekiso

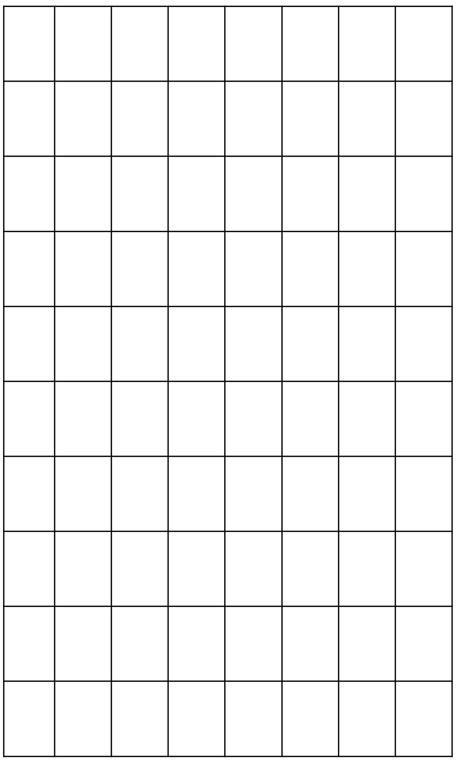
12. U O ngumbindi wesi sangqa. Khangela ubude ngokumeta I dayamitha __________ cm.

13. Gqibezela olu cwangcwiso lungezantsi.

Ingle	Uhlobo lweangle yi	Iidigris
ZQR	14.)	15.)

Unkosikazi Gardner uthelekisa iintlobo ezimbini zeembotyi (Jonga kule grafu engaphantsi):

16. Yiyiphi imbotyi ekhula ngokukhawuleza phakathi kweveki yesi 2 neyesi 3? ___________



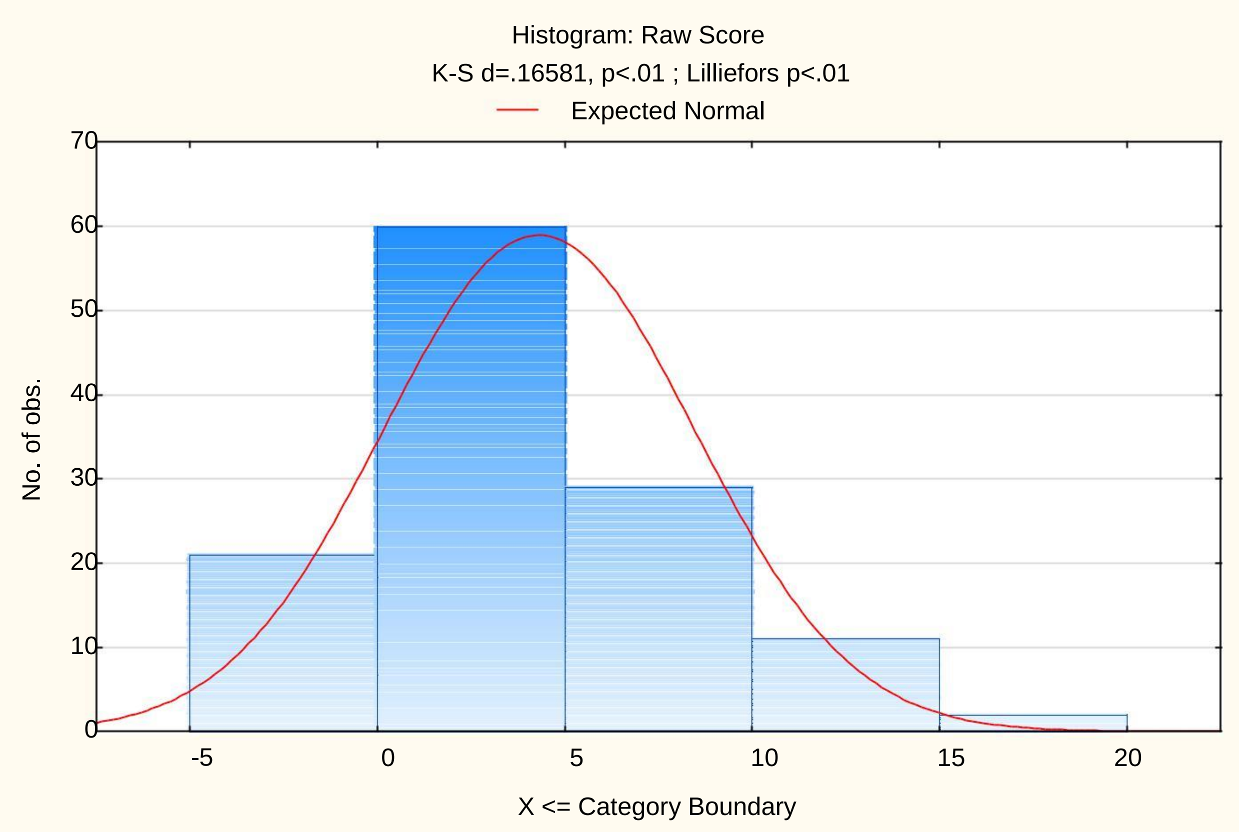
Kwenziwe uphando lokubonisa ukuba abafundi bahamba ngantoni xa besiya esikolweni. Olucwanganiso lungaphantsi lubonisa amanani abafundi abasebenzisa iindidi zezithuthi abahamba ngazo.

Uhlobo lwesithuthi	Inani labafundi
Imoto	
Ibhayisekile	
Itekisi	
Ibhasi	
Abahamba ngenyawo	

17. Bangaphi abafundi abathabatha inxaxheba kolu phando? __________________

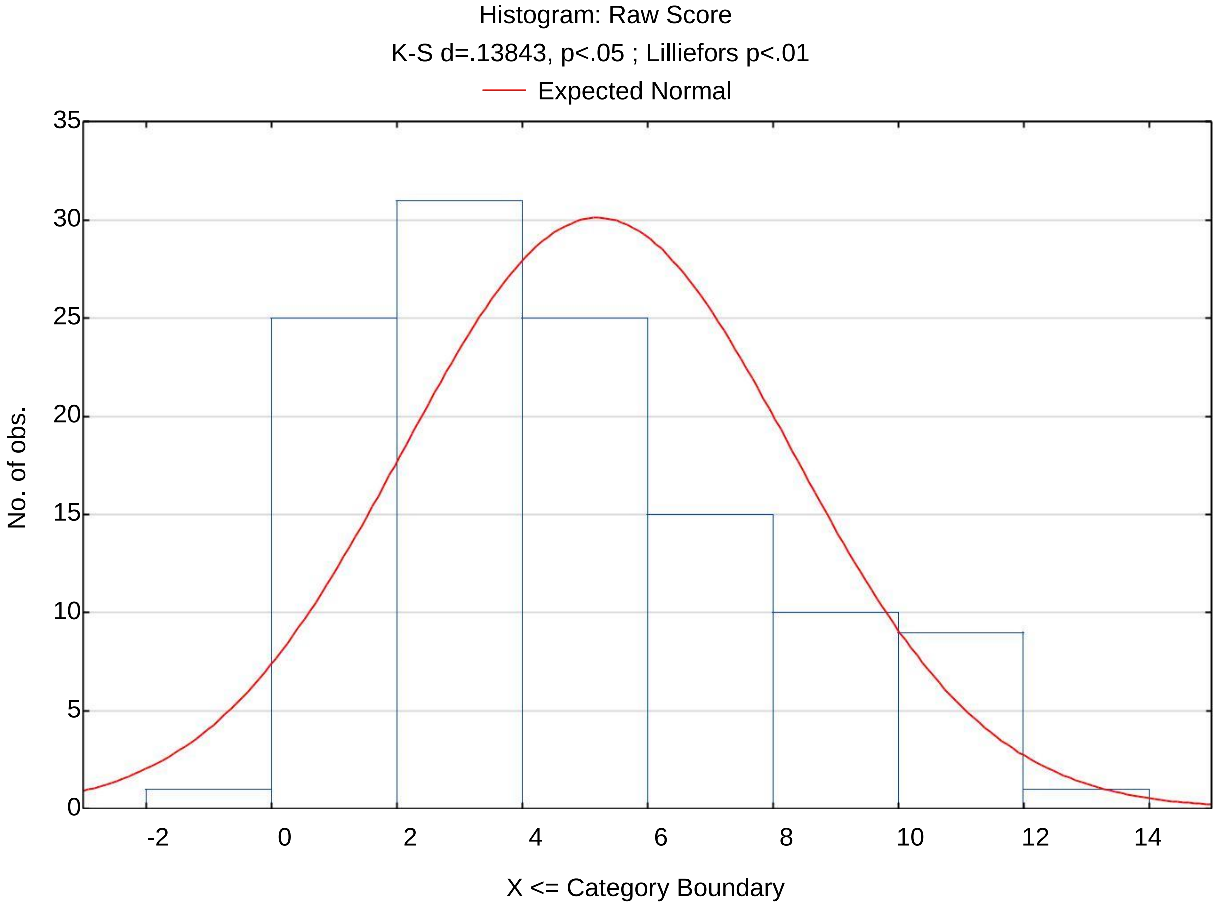
Appendix P: Grade 2 Normality Histogram

With d= 0.16581 and p<.01, the Grade 2 raw scores significantly deviate from normality.



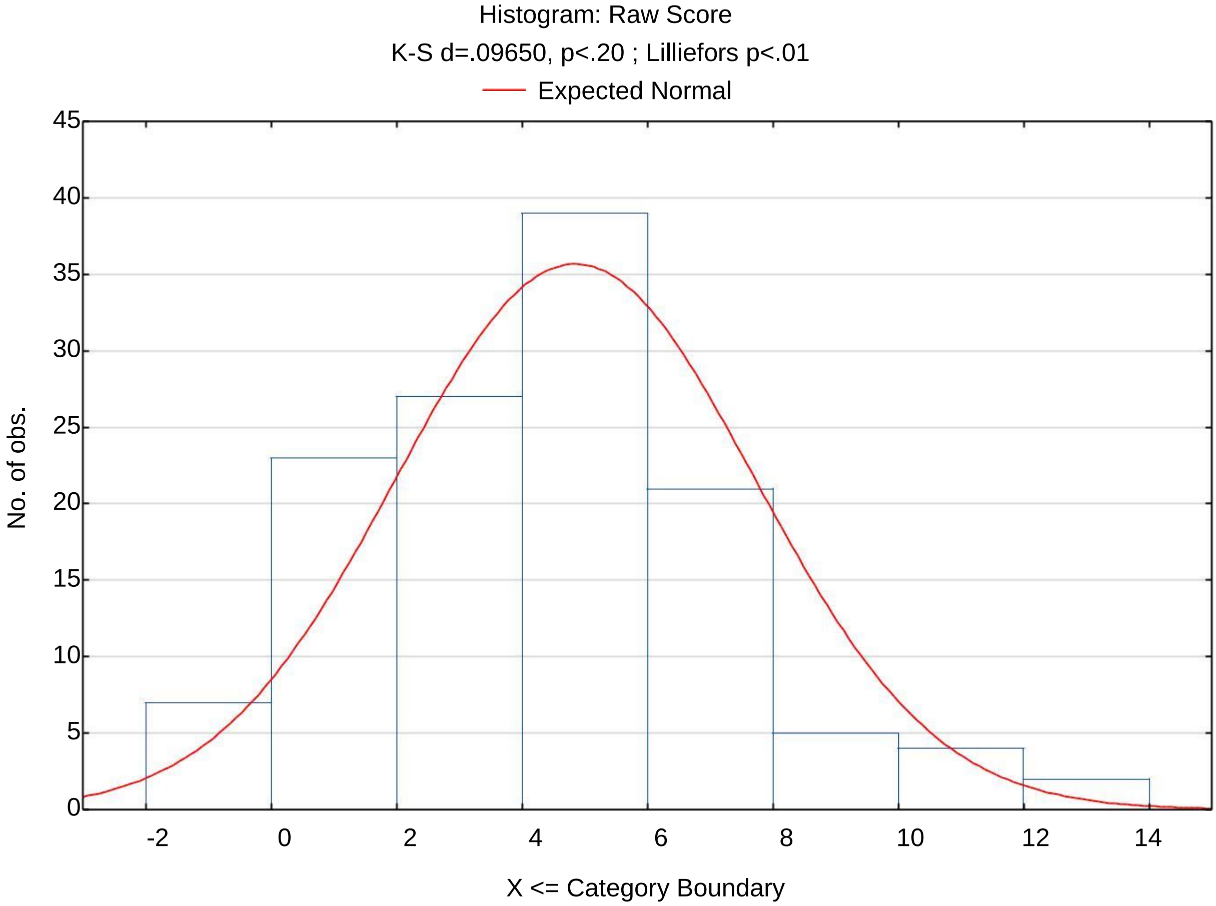
Appendix Q: Grade 3 Normality Histogram

With d= 0.13843 and p<.05, the Grade 3 raw scores significantly deviate from normality.



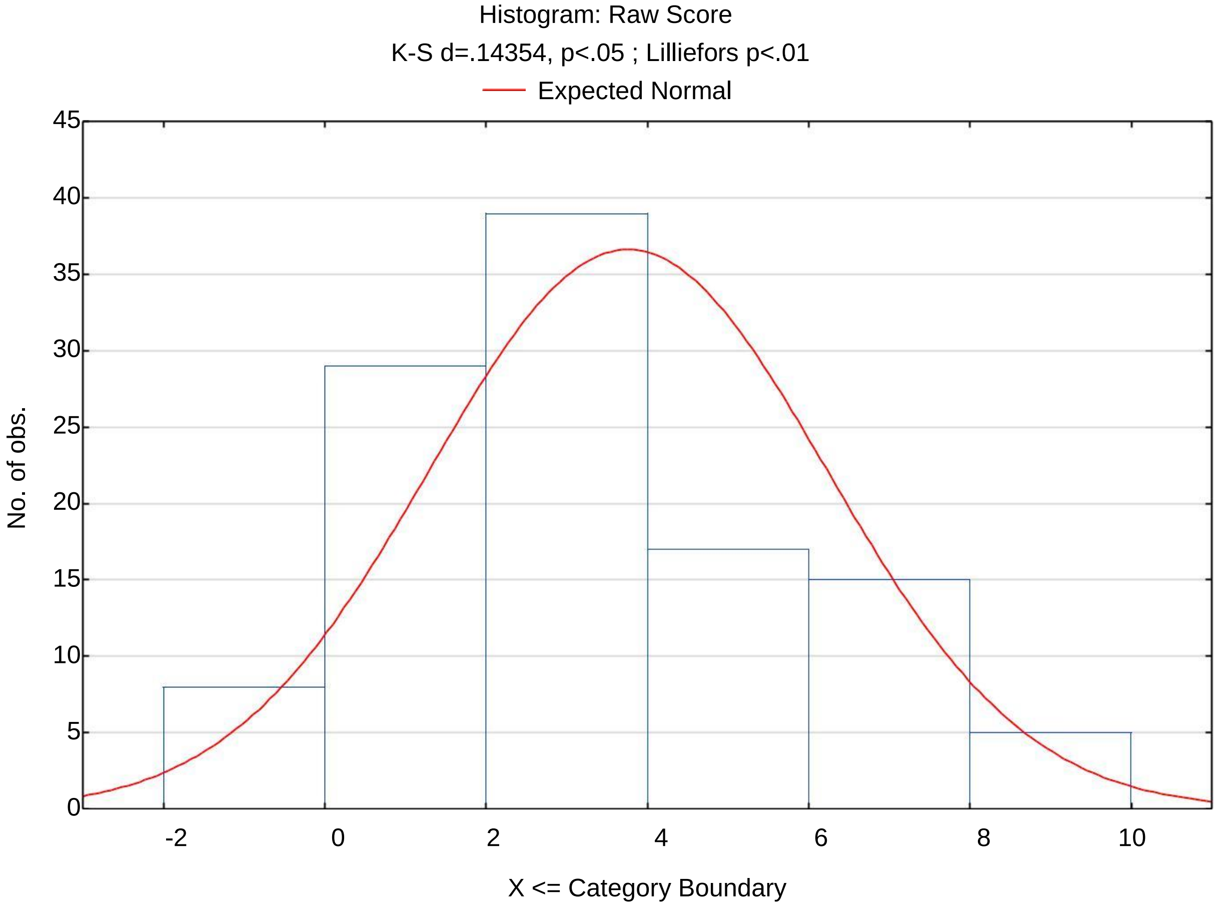
Appendix R: Grade 4 Normality Histogram

With d= 0.09650 and p<.20, the Grade 4 raw scores are normally distributed.



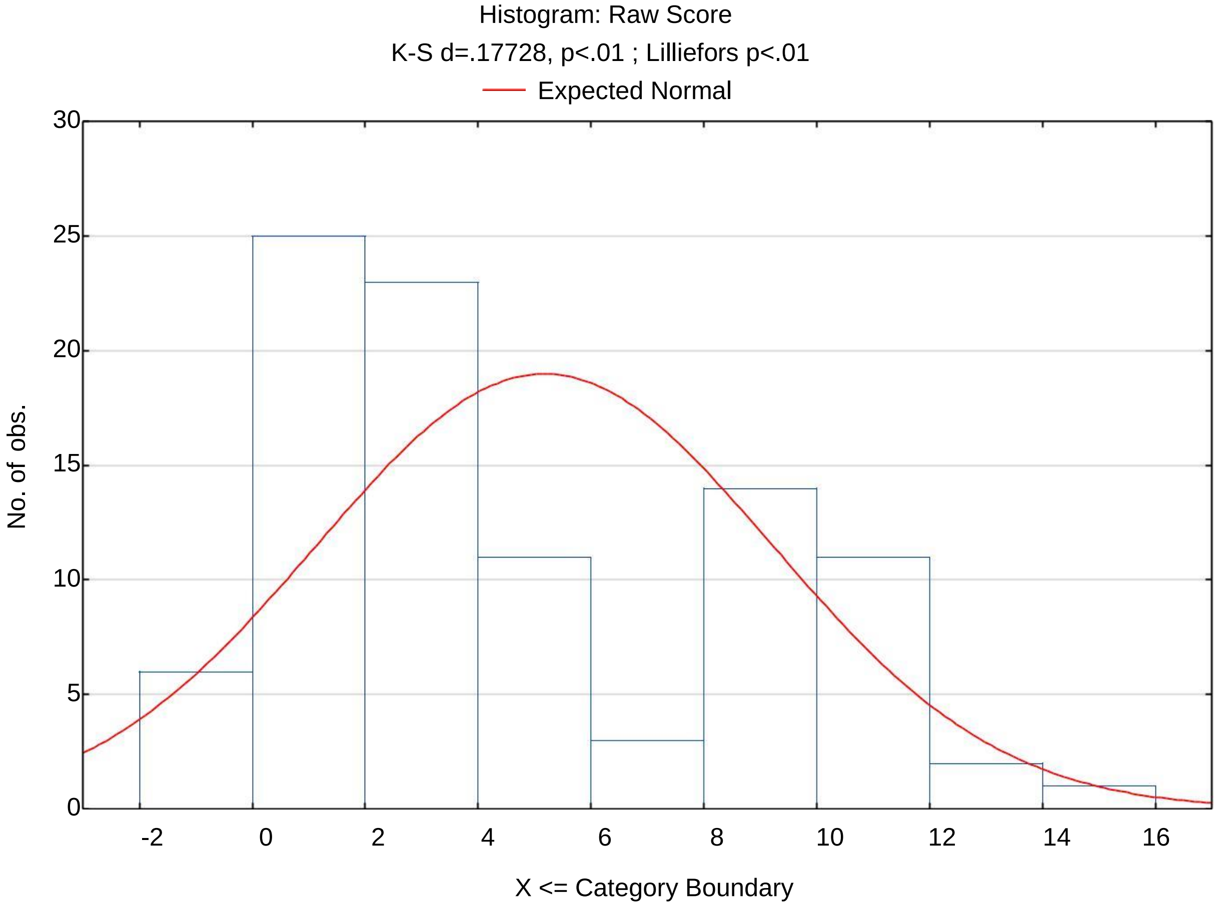
Appendix S: Grade 5 Normality Histogram

With d= 0.14354 and p<.05, the Grade 5 raw scores significantly deviate from normality



Appendix T: Grade 6 Normality Histogram

With d= 0.17728 and p<.01, the Grade 6 raw scores significantly deviate from normality.



Appendix U: Conversion of raw scores to stanines and percentile ranks for Grade 1 learners.

The following table represents the norms for learners in Grade 1. From this table a given raw score can conveniently be converted to a percentile rank and stanine. For example, a learner who scores 18 and above on the VASSI, would attain a stanine of 9. According to the stanine conversion table, this learner would be scoring within the 'very superior' range compared to his/her peers at that level. Furthermore, this learner would be at the top 1% (they performed better than 99% of their peers) of the class.

The average stanine for the Grade 1 class is 4.91156 (rounded off to 5), and the percentile rank is equal to 47. This means that when compared to the normal distribution the grade 1 learners are in the average range, they performed better than 47% of other learners in the norm group.

Raw Score	Percentile Rank	Stanine
0	-	-
1	1	2
2	11	3
3	15	3
4	23	3
5	31	4
6	39	4
7	47	5
8	57	5
9	65	6
10	72	6
11	74	7
12	82	7
13	88	8
14	92	8
15	93	9
16	95	9
17	98	9
18+	99	9
‾= .		
SD= 4.29		
N= 147		

Appendix V: Conversion of raw scores to stanines and percentile ranks for Grade 2 learners

The following table represents the norms for learners in Grade 2. From this table a given raw score can conveniently be converted to a percentile rank and stanine. For example, a learner who scores 17 and above on the VASSI, would attain a stanine of 9. According to the stanine conversion table, this learner would be scoring within the 'very superior' range compared to his/her peers at that level. Furthermore, this learner would be at the top 1% (they performed better than 99% of their peers) of the class.

The average stanine for the Grade 2 class is 4.87805 (rounded off to 5), and the percentile rank is equal to 45. This means that when compared to the normal distribution the grade 2 learners are in the average range, they performed better than 45% of other learners in the norm group.

Raw Score	Percentile	Stanine
0	1	3
1	18	3
2	37	4
3	46	4
4	54	5
5	63	5
6	66	6
7	73	6
8	77	7
9	82	7
10	85	8
11	90	8
12	-	-
13	95	9
14	97	9
15	98	9
16	98	9
17+	99	9
$\bar{}$= 4.31		
SD= 4.16		
N= 123		

Appendix W: Conversion of raw scores to stanines and percentile ranks for Grade 3 learners.

The following table represents the norms for learners in Grade 3. From this table a given raw score can conveniently be converted to a percentile rank and stanine. For example, a learner who scores 5 on the VASSI, would attain a stanine of 5. According to the stanine conversion table, this learner would be scoring within the 'average' range compared to his/her peers at that level. Furthermore, this learner would be at the top 51% (they performed better than 49% of their peers) of the class.

The average stanine for the Grade 3 class is 5.05128 (rounded off to 5), and the percentile rank is equal to 45. This means that when compared to the normal distribution the Grade 3 learners are within the 'average' range and have performed better than 45% of learners in the same norm group.

Raw Score	Percentile	Stanine
0	1	2
1	2	2
2	8	3
3	23	4
4	36	4
5	49	5
6	61	6
7	70	6
8	77	7
9	83	7
10	88	8
11	92	9
12	96	9
¯= 5.21		
SD= 3.10		
N= 117		

Appendix X: Conversion of raw scores to stanines and percentile ranks for Grade 4 learners.

The following table represents the norms for learners in Grade 4. From this table a given raw score can conveniently be converted to a percentile rank and stanine. For example, a learner who scores 9 on the VASSI, would attain a stanine of 8. According to the stanine conversion table, this learner would be scoring within the ‘superior’ range compared to his/her peers at that level. Furthermore, this learner would be at the top 9% (they performed better than 91% of their peers) of the class.

The average stanine for the Grade 4 class is 4.96875 (rounded off to 5), and the percentile rank is equal to 45. This means that when compared to the normal distribution the Grade 4 learners are within the ‘average’ range and have performed better than 45% of learners in the same norm group.

Raw Score	Percentile	Stanine
0	1	2
1	6	2
2	12	3
3	24	4
4	35	4
5	45	5
6	62	6
7	75	7
8	81	7
9	91	8
10	-	-
11	95	9
12	98	9
13+	98	9
‾= 4.85		
SD= 2.86		
N= 128		

Appendix Y: Conversion of raw scores to stanines and percentile ranks for Grade 5 learners.

The following table represents the norms for learners in Grade 5. From this table a given raw score can conveniently be converted to a percentile rank and stanine. For example, a learner who scores 10 and above on the VASSI, would attain a stanine of 9. According to the stanine conversion table, this learner would be scoring within the ‘very superior’ range compared to his/her peers at that level. Furthermore, this learner would be at the top 1% (they performed better than 99% of their peers) of the class.

The average stanine for the Grade 5 class is 5, and the percentile rank is equal to 44. Compared to the normal distribution the Grade 5 learners achieved within the ‘average’ range and have performed better than 44% of other learners in the same norm group.

Raw Score	Percentile	Stanine
0	1	2
1	8	3
2	21	4
3	33	4
4	53	5
5	68	6
6	75	7
7	82	8
8	93	8
9	96	9
10+	98	9
¯= 3.76		
SD= 2.46		
N= 113		

Appendix Z: Conversion of raw scores to stanines and percentile ranks for Grade 6 learners.

The following table represents the norms for learners in Grade 6. From this table a raw score can be converted to a percentile rank and stanine. For example, a learner who scores 15 and above on the VASSI, would attain a stanine of 9. According to the stanine conversion table, this learner would be scoring within the 'very superior' range compared to his/her peers at that level. Furthermore, this learner would be at the top 1% (they performed better than 99% of their peers) of the class.

The average stanine for the Grade 6 class is 4.84375 (rounded off to 5), and the percentile rank is equal to 46. Compared to the normal distribution the Grade 5 learners achieved within the 'average' range and have performed better than 46% of other learners in the same norm group.

Raw Score	**Percentile**	**Stanine**
0	1	2
1	7	3
2	21	3
3	33	4
4	47	4
5	57	5
6	64	5
7	-	-
8	-	-
9	71	7
10	77	7
11	86	8
12	92	8
13	97	9
14	98	9
15+	99	9
$\bar{}$= 5.18		
SD= 4.034		
N= 96		