DIFFERENTIAL EFFECTS OF CHILD-CHARACTERISTICS ON EARLY LITERACY AND NUMERACY SKILL-ATTAINMENT AT SELECTED LOW AND HIGH-PERFORMING SCHOOLS IN THE NORTHERN PROVINCE OF ZAMBIA

By

EBBY MUBANGA

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CERTIFICATE OF APPROVAL

The Thesis by **Ebby Mubanga** is approved as fulfilling the requirements for the award of the Degree of Doctor of Philosophy in Educational Psychology of the University of Zambia.

Signed: ……………………………….. Date: ………………………………..

Signed: ……………………………….. Date: ………………………………..

Signed: ……………………………….. Date: ………………………………..

DECLARATION

I, Ebby Mubanga, hereby solemnly declare that this Thesis represents my own work and has not previously been submitted for a degree at the University of Zambia or any other University and that it does not incorporate any published work or material from another University.

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DEDICATION

Dedicated in memory of my beloved mother, the late **Albina Bwalya**. Mum, I wish you knew how deep the foundation of hard-work you dag in my life. You always kept my spirits high with your unique and a rare spirit of perseverance. Your untimely demise was the greatest pain and challenge I had to endure in my academic journey especially that you said bye to this world when I was in the first term of my first year at a Primary Teacher's College. I have come to believe that, "the people you care most about in life are often taken from you too soon." You left at a time when, I needed to learn more from you and most unfortunately, I had no time to say thank to you for all the great things you did to me. I am grateful that you demonstrated it all to me that 'Hard-work Rewards', indeed it does!

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Abstract

The main purpose of this study was to identify the different risky (hindering) and supportive (enabling) factors for the acquisition of grade-level early literacy and numeracy skills is the first grade. The study sought to establish the interplay and influence of child-characteristics and environmental factors in the context of school quality on literacy and numeracy skills.

A total of 100 children drawn from five low and five high performing schools constituted the sample. These children were subjected to individual tests to assess their skills in reading, writing and mathematics tasks. Seven instruments (biographical sheet, Family literacy questionnaire, Behaviour Rating Inventory for Executive Function (BRIEF), Electrocardiography(ECG) measure, Basic Assessment Skill Assessment Tool (BASAT), Mathematics Assessment Battery and the DLE mathematics were used.

Based on the research evidence on differential susceptibility, we hypothesized low literacy and numeracy attainment levels among children with high stress reactivity in schools with poor didactics and high literacy and numeracy attainment levels among children with low stress level reactivity in schools with poor didactics. It was further hypothesized that low SES and deprived home environments elevated levels of stress reactivity whereas high SES suppressed stress reactivity as the influence of biological sensitivity is dependent on either the positive or negative settings.

Background variables comprising child-characteristics, home and school factors helped to predict reading, writing and numeracy skills. Children's parents responded to questionnaires to give information about home literacy circumstances and teachers gave information about each child's behaviour as observed in class.

Specifically, school quality was a strong predictor of reading and writing, but not mathematics skills. Surprisingly, preschool, home literacy and home learning support were not strong predictors of literacy and numeracy skills, except for alphabet knowledge. Children's performance in literacy and numeracy skills was generally low compared to what other studies have found regarding the predictive role of variables such as executive functions.

Though RSA (stress) reactivity was not a strong predictor, positive associations were noted with preschool, phonemic awareness, reading and writing as well as mathematics number-facts. On the other hand, RSA (stress) reactivity negatively correlated with mathematics number-sense.

From the study, it very clear that phonemic awareness came out as most problematic variable as it could not significantly be predicted by any background variable. This suggests serious challenges as far as the teaching of literacy is concerned. Since research strongly points to phonemic awareness as one of the strong predictors of early literacy, this research has just also revealed that some of the poor reading levels being experienced in Zambia are more closely connected to the neglect of applying phonemic awareness skills in schools. Zambian teachers seem not to have adequate knowledge and methods of teaching phonemic awareness skills to young learners.

Low and high performing schools had different strengths and weaknesses in terms of their influence on children's literacy and numeracy performance. For example, high performing schools performed better on reading and writing and mathematics number-sense, while low performing schools performed better on mathematics number-facts. Furthermore, there were marked differences with child characteristics and home factors and how they also influenced outcome variables.

Based on the findings of the study, it is highly recommended that early literacy and numeracy skills attainment is given equal attention in terms of research and innovation in order to improve the quality of service delivery in colleges of education and later to young learners in primary schools. Furthermore, consented collaborative effects need to be coordinated by the Ministry of Education, Vocational Training and Early Education in order to maximize learning opportunities at school and at home. Therefore, parental involvement in the education of their children should be emphasized l so that parents' and teachers' in-put benefit children's academic needs for the best development of early literacy and numeracy skills.

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ACRONYMS

- BASAT- Basic Skills Assessment Tool
- BRIEF-Behaviour Rating Inventory of Executive Function
- CLT-Communicative Language Teaching
- DV-Dependent Variable
- ECE-Early Childhood Education
- ECG- Electrocardiography
- ECZ- Examinations Council of Zambia
- HPS-High Performing Schools
- IV-Independent Variable
- LPS-Low Performing Schools
- NBTL-New Breakthrough to Literacy
- PA- Phonological Awareness
- PCK-Pedagogical Content Knowledge
- PRP-Primary Reading Programme
- RSA-Respiratory Sinus Arrhythmia
- SACMEQ-Southern African Consortium for Monitoring Educational Quality
- SD-Standard Deviation
- SR- School Readiness
- UNESCO-United Nations Education Scientific Commission
- UNZA-University of Zambia
- US-United States
- ZATEC-Zambia Teacher Education Course
- ZBEC-Zambia Basic Education Course
- ZPC-Zambia Primary Course

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

1. 1.1 Overview

This chapter presents the background of the study focusing on low literacy and numeracy levels in Zambian primary schools. Three perspectives namely: the global, African and Zambian have been referred to in order to give a broader and specific picture. Literacy and numeracy performance have been explained in the light of child characteristics and family circumstances as key factors which can have a direct bearing on children's performance in different academic skills in school. In this study, school quality refers to low and high performing schools. Child characteristics on the other hand imply those personal attributes of a learner such as: age, gender, executive functioning, home possessions and other aspects at home which include: siblings, relationships at home, home literacy, home possessions(socioeconomic status (SES) and home learning support.

The study also recognizes Early Childhood Education (ECE) to have a direct or indirect bearing on academic performance because a number of parents choose to take their children to preschool. It, is however, worth noting that there are various reasons which motivate parents and caregivers to take their children to preschool, academic preparation is just one of them while child care could be another among others. Depending on the prevailing circumstances, exposure of the child to preschool could have a lasting effect, positive or negative, on the child's social and learning behaviour and capacity. With regard to literacy and numeracy attainment, it is important to establish the extent to which foundational experiences in life enhance early academic skills. Early childhood experiences, whether in the home or in a school set-up cannot be detached from child development in general.

Other key components presented in this chapter include: the statement of the problem, purpose of the study, significance of the study, objectives of the study, hypotheses of the study and the theoretical framework. The chapter also highlights the study limitations and definition of operational terms.

1.1.2 Low literacy prevalence - global perspective

Considering the salience of language and literacy in our society, learning to read may be the most important achievement in children's lives (Neo et al, 2012). Among U.S. fourth-grade students, only 34% read at the proficient level or above indicating that this critical achievement is not easily acquired. Low literacy levels manifest in different ways and therefore, can be described quite divergently. One of the common examples of low literacy levels is dyslexia which is a developmental disorder of reading that occurs in persons with otherwise normal intelligence, sensory acuity and general motivation (World Health Organization, 1993). Remarkably, approximately 5–18% of the population is affected by dyslexia (Shaywitz, 1998; Snowling, 2000). Individuals with dyslexia often have associated difficulties with writing, spelling, motor co-ordination and attention abilities, which of course vary across individuals, making it difficult to specify the etiology (Habib, 2000; Snowling, 2001). Therefore, literacy development difficulties is closely related to dyslexia especially among learners in the mainstream classes who usually may not be associated with any disabling condition. In this vein, Anthoni et. al. (2007) note that developmental dyslexia is a specific disorder in learning to read and spell in spite of adequate educational resources, normal intelligence, no obvious sensory deficits and adequate sociocultural opportunity.

1.1.3 Low early literacy and numeracy profiles in Zambian

Zambia is a multilingual nation with more than 70 dialects clustered around 7 local official languages which are regionally distributed with English as the official language. In such a complex situation, early literacy and numeracy teaching and learning becomes an interesting research terrain. For this and many reasons, the Zambian education system, especially in government primary schools has generally been associated with low early literacy and numeracy attainment. This trend has been a great source of concern to the Ministry of Education, parents and other stakeholders because the quality of education in the country has persistently and generally remained poor. This situation has prompted lots of Government efforts with the aim of trying to improve the standards of education in the country.

Scholars have taken keen interest in trying to offer empirical evidence on the literacy situation in Zambia. For example, Matafwali (2010) argues that the un-favourable literacy achievement levels in comparison with other countries in the sub-Saharan region has been an incentive for the Zambian government to change the language policy in an effort to improve literacy standards in the country. A new language policy called the Primary Reading Programme (PRP) was therefore, ushered in, with the New Break Through to Literacy (NBTL) as one of its major components.

The PRP emphasized the teaching of early literacy in the first grade using a local or most familiar language. However, research evidence from various studies has suggested that the impact of the language of instruction policy through the PRP was negative as it did not succeed in generating reading competence in many children. It is further observed that despite the PRP's country-wide implementation in all government primary schools, pupils' literacy levels have still remained below expectation although not at every school This is against the background that there is overwhelming evidence indicating that education in unfamiliar language is assumed to be an enormous challenge for young children because children have to learn two complex skills simultaneously (Tambulukani & Bus, 2009).

Studies in literate societies have also made plausible discoveries that a rather high level of proficiency in the language of instruction is required for children to benefit from reading instruction in school (Dickinson and Tabors, 2001). Children need to understand age-appropriate written texts including more complex oral language than the language that is typical for daily communication (Bus, van IJzendoorn, & Pellegrini, 1995).

Other studies do confirm the high prevalence of low literacy levels in Zambia. Kelly (2000) in his study reports that grade six pupils performed considerably below the levels expected of those in sixth grade in reading. Reading levels of some grade six pupils fell within the level expected of grade four, and that scores of some grade five pupils in both rural and urban schools fell within the performance band expected of grade three pupils. Similarly, the scores of some grade four pupils in rural and urban schools fell within the performance band of grade two pupils.

In another study by the National Reading Committee (1997) in four Lusaka Schools, it was estimated that, approximately 60 % of pupils leaving school at the end of grade seven had extremely poor reading skills in English and were almost completely illiterate in their local languages (Kotze & Higgins; 1999). Williams (1993) also conducted a comparative study in which he focused on reading levels of Zambian and Malawian pupils in grades three, four and five, both in English and in Chicewa. This study indicated that, on average, pupils in the sampled Zambian schools could not read a text two years below their own grade level compared to their Malawian counterparts. The Southern African Consortium for Monitoring Educational Quality (SACMEQ; 1998) further reported poor reading performance at grade six level in the Zambian Basic schools (Nkamba & Kanyika, 1998). The countries involved were Mauritius, Namibia, Zambia, Tanzania, and Zimbabwe. The study demonstrated that, in 1995, of the 148 grade six pupils in the defined target population, only 25 percent could read at defined minimum levels and only three percent could read at desirable levels (Nkamba & Kanyika, 1998).

The language of instruction policy has been a matter of concern from the pre-independence era. Earlier, from 1965 to 1969 for instance, English had been used as a medium of instruction and also as a language of initial literacy from the time a child started grade one. Ministry of Education (1996: 39) in Mayeba (2009) reveals that 'for over thirty years, children who have had very little contact with English outside school, but have been required to learn concepts through English medium have had unsatisfactory experience.' Such a situation has been believed to have a negative effect on children's learning progression because children who start poorly in literacy during foundational years are not likely to make significant improvements in later years. This is so because academic skills like any other skill are cumulative and to a great extent extend depending on the quality of the foundation.

Though not yet especially investigated, in addition to linguistic diversity child characteristics, family factors and pedagogical-didactics could be responsible for low literacy (including numeracy) levels that prevail among most pupils in government school. Regarding low literacy and numeracy levels in primary schools, the Zambian situation is discussed with reference to some studies that have been conducted so far. Child and family characteristics on the other hand reveal the importance and impact of the home environment in relation to academic skill-development and attainment in early and later years. Children come from different home settings where they get different support from their caregivers. Caregivers may be children's biological parents or others such as their grandmothers and grandfathers, uncles and aunties, among others. Teacher quality and facilities in school are critical aspects to school quality and learner-performance. Therefore, the capacity and competence of teachers in relation to their training also adds to school quality described as low or high performing.

A number of other strides made on research in literacy and numeracy development have also been highlighted. However, it is clear from available research evidence that more studies have been conducted on literacy compared to what has been done on numeracy. In the present study, the two skills were studied and presented in the context of low performing and high performing schools as schools differed on account of quality.

The problem of low reading levels in Zambian primary schools, formerly basic schools have been noticed earlier in a number of studies. Matafwali (2005) found that only 23% out of 106 pupils in grade three from 4 randomly selected schools in Lusaka Province were able to read at a level expected for their grade. Matafwali (2010) in her study which sought to explore the role of oral language in the acquisition of literacy skills with particular focus on Zambian languages and English language further established that the literacy levels of a majority of Zambian children were remarkably low despite having a rich literacy programme in place. In another study conducted on 60 Grade two poor readers (identified by teachers) from selected schools in Northern Province, Kalindi (2005) argues that only 13% could read two syllable words, and only 8% could identify 20 letters of the alphabet. These low reading attainment percentages have been alarming, hence the need for vigorous research efforts to correct and improve the scenario. As these low results suggest, despite the reform of the language policy, the majority of the Zambian children are still performing below the expected level, and far too many are at potential risk of being conventionally classified as reading disabled.

In an effort to address low literacy and numeracy competence levels in government basic schools, some innovations have been under way. In this vein, Tambulukani et al (1999) in Matafwali (2010) argues that the literacy achievements under the New Language Policy in particular the NBTL have been documented. The fast-track one year initial literacy course in each of the seven official Zambian languages seemed promising.

Other efforts had been underway as well. For example, before the PRP was introduced, government through the Examinations Council of Zambia (ECZ) had introduced basic competence tests in literacy and numeracy at grade four . The grade 4 basic literacy and numeracy were only conducted for a period of about five years from the late 1990s upto in the early 2000. These tests were nationally conducted and were aimed at assessing young lower primary learners' competences in basic literacy and numeracy before reaching their fifth grade. Unfortunately the tests could not continue as government had no money to continue conducting them. Regrettably, this innovation discontinued and children's performance in literacy and numeracy still have remained low and there is no nation-wide monitoring mechanism to assess literacy and numeracy skills among young learners. Both literacy and numeracy competence levels were being assessed when children reached their fourth grade.

As already alluded to, it has been noticed, however, that whilst certain factors (for example executive functions, preschool, SES and home literacy) are believed to predict both literacy and numeracy skills, research evidence demonstrates that more studies have been conducted on literacy compared to what has been done on numeracy. This is also true for Zambia where there seems to be more focus on early literacy with very little emphasis on numeracy. In the present study, however, literacy and numeracy skills were studied in the context of low performing and high performing schools. Braunmiller, (2008) also acknowledges that development of reading is viewed as a central responsibility of school with little focus on understanding the cognitive processes that contribute to the development of mathematical skills.

Given this unbalanced research preference to literacy, it would be beneficial for studies in Educational Psychology on young learners to render equal attention to both literacy and numeracy skills as they are critical foundational academics skills whose development does not take place in isolation. A number of studies so far conducted in Zambia are biased to literacy (reading and writing) aspects as well. Chansa-Kabali (2014) also indicates that many factors are said to influence the acquisition of reading. However, many studies in Zambia focus on classroom factors such as methods and language of instructions.

The present study, however, creates a paradigm shift from studied based on methods and language of instruction to differential effects of child characteristics, home factors and school quality on children's performance on literacy and numeracy. Child characteristics refers to: age, executive functions (self-regulatory skills which include: inhibition, shift, working memory, emotional control and planning and organization), RSA (stress) reactivity and exposure to preschool. RSA (stress) reactivity is a measure of the child's reaction to any environmental challenging situation. Child characteristics are qualities which the child take with him/her into the school. The inclusion of the RSA (stress) reactivity as one of the child characteristics in the context of the a new theory called the Differential Susceptibility Theory.

Propounded by Belsky, differential susceptibility hypothesizes that individuals vary in the degree they are affected by experiences of qualities of the environment they are exposed to. Some individuals are more susceptible to such influences than others, not only to negative but also to positive. The inclusion of this aspect in this study make it a unique and important one. The study sought to explore the combined effect of multiple factors which surround the child that determine literacy and numeracy skill-attainment.

Home factor in this study refers to home literacy, home learning-support, socio economic status, relationship to care-giver and number of children (siblings) in the in other grades in the home. School quality on the other hand helps to categorize a school from which the sample for this study was drawn as low or high performing school.

1.1.4 Early literacy teaching methodology in Zambia

As alluded to above, children's academic performance, positive or negative could be attributed to a number of factors. Arising from the low literacy revealed through research, it is possible that certain conditions at government primary schools render a contribution to children's low interest leading to poor performance in initial literacy and numeracy. Numerous curricular and methodological innovations have been underway, but these have not brought desirable fruits to most children and caregivers. This suggests that critical factors remain unchecked, hence the persistent poor literacy achievement. Quality teacher training for classroom instruction could be one of such factors. In most government primary schools in Zambia, teachers do not possess the same type of training and competences. Some teachers at these schools received an initial two-year primary teachers training. Another group of teachers received a one year fast track teacher training course and did their second while in the field. Later, in the quest to improve the quality of literacy levels among learners, the teacher training curriculum expanded to three years for initial (pre-service) training. The qualification was also upgraded from a primary teacher's certificate to diploma one. Except for those training to teach at preschool level, from government colleges and a few private colleges of education, primary school trainees now graduate with a Primary Teacher's Diploma of the University of Zambia. The former teacher-training course under the Zambia Teacher Education Course (ZATEC) used to take two years before a student graduated as a teacher.

The Primary Reading Programme (PRP) may have contributed to the type and poor quality of literacy teaching. When the PRP got introduced in schools about ten years ago, practicing teachers in schools only received short-training lasting less than two weeks. In addition, this training though it started at national level, was not conducted in one place by the same trainers. Instead the training was run in isolated settings through representatives from provincial, district, zonal and school levels. As training moved from national level to schools through different trainers, the duration of training and amount of content were drastically reduced. Later, all teachers at basic school level, especially those handling lower primary grades (grade 1 to 4) got oriented to the new approach. A new literacy teaching approach got introduced in schools, meant for young learners.

Matafwali (2010) describes the NBTL of the PRP as an adaptation of the Molteno project of South Africa, originally developed to teach functional literacy skills to learners in their first language. The NBTL, therefore, is an approach that brings into the classroom language that children are already experiencing in the home, works with children to recognize familiar spoken words when translated into a written code, and to generate written language. In short, this language policy takes cognizance of the role of the mother tongue in the development of early reading skills. Feldman (2004:278) noted that "the language that preschoolers hear at home has profound implications for future cognitive success."

Regarding literacy teaching methodology, the Zambian situation can further be described to have a mixture of training and orientation. This is so because teachers in government primary schools have not been subjected to a uniform training. This follows a number of transformations that have taken place in the curriculum and more especially in approaches of teaching and teacher-training itself. For example, before the introduction of the Primary Reading Programme (PRP) in the late 1990s, the Zambian Government through the Ministry of Education had adapted the Communicative Language Teaching (CLT) approach under the Zambia Basic Education Course (ZBEC). The emphasis of this approach was on the use of language for communication rather than on its form. Before the ZBEC was introduced, early literacy was taught through another approach called the Audio-Lingual approach under the Zambia Primary Course (ZPC). Unlike the CLT, the Audio-Lingual approach was characterized by its emphasis on language form rather than the function and use of language. This situation suggests that the Zambian early literacy arrangement has been in needy for more research. It is for this reason that since the 1960s to date the primary education system, particularly the literacy teaching methodology has been subjected to a series of different innovations. Such efforts are aimed at improving literacy attainment which would eventually translate into education of high quality. Such innovations, however, have not translated into positive achievements in reading and writing of children in schools. Furthermore, lack of homogeneity in teacher-training from one generation of teachers to another seems to be another cause of pupil-failure in the basic academic skills.

A situation of training teachers differently on the basis of duration of course and mode of delivery suggests that even in terms of the content knowledge and methodology would be different. A good number of teachers who were trained under the Zambia Primary Course (ZPC) in the 1980s and the Zambia Basic Education Course (ZBEC) in the 19090s still teach in some government primary schools today. Although all teachers received some short-term orientation in PRP as well as in the Primary Literacy Programme (PLP), the former trainings (i.e. ZPC and ZBEC) had taken two years. It is possible that teachers still mastered the knowledge and skills received from the initial training compared to the PRP orientation which was only done through school-based workshops for a short period of time. Moreover, these orientation courses were only conducted in rather inconsistent ways from school to school as the trainers per school were not the same people, making the training unreliable. With this situation at play, the quality of instructions could be un-even and would turn out to be negative as the shift from one teaching methodology to another may not be automatic.

It is clear then that a number of factors seem to be at play to influence the nature and quality of education for children in primary schools. Language of instruction-policy-issues, inconsistencies in teacher-training progammes and methodologies have all a bearing effect on what remains for the children in academic skill acquisition.

1.1.5 Early childhood education

Among the numerous factors which can influence school progression for better or for worse are early experiences through Early Childhood Care and Education (ECCE). Feldman (2004: 281) reveals that "Preschools, also known as nursery schools, are more explicitly designed to provide intellectual and social experiences for children. Because they tend to be more limited in their schedules, typically providing care for 3 to 5 year-olds, preschools mainly serve children from middle and higher socioeconomic levels." However, preschools differ significantly from one country to another according to views that different societies hold of the purpose of early childhood education (Lamb et al, 1992). For this reason, parents take their children to different schools of their choice from where children acquire different skills and behaviours some of which can help children excel or lag behind academically.

Numerous studies cite the strong relationship between essential reading-related skills on entry into school and later reading achievement (Tunmer, et al., 2006; Whitehurst & Lonigan, 2003). School success is closely connected to reading ability and in turn later success in society. Children who struggle to read early tend to struggle right through their schooling and "are effectively prevented from capitalizing on the power of education to improve and enrich their lives" (Honig, 1996: 1). Other studies have shown that number and letter naming are highly correlated in preschool (Piasta, Purpua, & Wagner, 2010), probably because distinguishing letters from numbers is a first in learning letters and numbers.

1.1.6 Preschool: Another challenge to early literacy and numeracy learning in Zambia

There is also strong evidence to suggest that the problems children experience in learning to read during the elementary school years and beyond are related to the emergent literacy skills they bring with them from the preschool and kindergarten period (Lonigan, 2006; Lonigan et al., 2000; Shonkoff rt al, 2009; Wagner et al., 1993). This view also seems to suggest that, with or without pre-school, children still experience reading difficulties. The question one would want to ask then is: “how much emergent literacy does pre-school offer to children entering first grade?” This question can be answered in research and this study offers some of the explanations in later chapters. In as much as preschool prepares learners for the early grade, it would be important to establish the extent to which preschool can enhance early learning.

There are numerous challenges associated with learning to read as reading is a critical foundation for children’s academic success. Children who read well read more and, as a result, acquire more knowledge in several domains (Stanovich, 1986). Reading as an academic skill has a long history and its developments depends on the consistent efforts and experiences throughout a child’s life. It is for this reason that a number of possible factors need to be examined right from the child’s foundational years in order to establish a clearer understanding of what issues surround children’s attainment in key academic skills such as literacy and numeracy.

Regarding the teaching of numeracy and in comparison to literacy, the Zambian situation has not enjoyed much inquiry and innovations. However, it is worth mentioning that English Language has been the official medium of instruction through which numeracy is taught right from grade one up to the tertiary level of education. To some extent, the literacy teaching approaches do influence the teaching of numeracy in some way. Though more effort seem to be stressed on the teaching of literacy, numeracy cannot be detached from normal life. To stress the importance of numeracy skills, Mercer and Mercer (1993) argue that daily living requires numerous math skills, for example planning and monitoring time, shopping, computing percentages, estimations among others. Cognitive factors are needed as the student progresses from lower level math-skills to higher order ones. In this case, the concept of learning readiness in math instructions is of crucial importance. From what has been discussed above, the Zambian situation suggests a complex literacy teaching and learning arrangement given the many strides taken without fully resolving the problem.

A Study conducted in South Africa shows that South African students' poor mathematics performance on national and international tests can be attributed to the gap the children begin schooling with from different socio-economics homes. Wright et. al. (2000) assert that this gap continues to grow the longer students are in school. Early childhood research highlights the significant educational gains of exposing young children to quality, structured mathematical play or activity that goes beyond what is learned within the family and community.

Research on mathematical instruction among South African students revealed poor content knowledge of teachers and lack of relevant instruction van der Sandt and Niewoudt, 2003). Also, studies on factors that impede mathematics conceptualisation indicated that learning mathematics in a language that is not a student first language create complex processes (Adler, 2001). Such challenges lead to code-switching that teachers are afraid of (Setati & Adler, 2001).

Fifty years since independence, pre-school in Zambia had not been part of the formal education structure. For this reason, not all children entering the first grade would have a pre-school background. For those entering school for the first time in the first grade, initial literacy could start in the first year while for those who could have been to pre-school before would be at an advantage as a result of an early exposure. It is not, however, a guarantee that all children who go to preschool would be better in the first grade than their counterparts who could not have been there.

Internationally, a large body of research has demonstrated that early childhood education can prevent early academic failure and that it has positive long-lasting effects throughout the lives of children from poor families (Myers, 1998). High-quality early educational intervention (EEI) may ameliorate and prevent further deterioration and delays in children's development, particularly for children who live in poverty (Consortium of Longitudinal Studies, 1983). During recent decades, the importance of early childhood education programmes has been increasingly recognised at academic and political levels in countries around the world (Woodill, Bernhard, & Prochner, 1992).

In Zambia, the term Early Childhood Education (ECE) is used to refer specifically to the education issues of children from birth to six years, as provided in the Ministry of Education Strategic Plan 2003 to 2007 and the Education for All (EFA) Framework of 2004. Early Childhood Education is the level of education formal or informal, which a child between 0-6 years of age undergoes before attaining the compulsory age of 7 years of entry of primary school in Zambia (UNESCO, 2011). Historically the Zambian government participation in Early Childhood Education has been minimal. The Day Nurseries Act of 1957 was the first innovative step toward recognition of the importance of Early Childhood Care, Development and Education by the government. This Act has been in effect, but the 2004 GRZ Gazette shifted the responsibility to providing ECE services to the Ministry of Education. Later the formulation of the ECE policy has been another giant step in strengthening efforts to provide ECE services (UNESCO, ibid).

Despite policy pronouncement regarding the provision of preschool in Zambia, there is no single sector in Zambia that can effectively provide ECE services to adequately meet the growing needs. The policy aims to provide these services between 0-6 years, as this is the period of fundamental growth during child development. Though this policy does not commit government to provide ECE services, more positive innovations have unfolded where government has resolved and committed itself to make early childhood education compulsory to all eligible children before they enter the first grade. This gives an advantage to all the children especially from poor families who could not manage ECE services from private providers. Previously the Curriculum Development Centre (CDC) did not play an active role in preparation of the curriculum and teaching and learning materials. However, with the policy pronouncements by government to introduce preschool at all government mainstream schools, the CDC had taken centre stage in providing teaching and learning materials for all schools in Zambia. Materials such as the curriculum, teachers' guides and learners' books among others are now available. In addition a number of government primary schools opened ECE classes while other schools are yet to open more. In taking a practical response to preschool pronouncements, primary colleges of education have started enrolling students specifically to train in the ECE programmes so that all government schools should sooner or later be equipped with qualified staff to teach children in foundational years. These steps are a demonstration that ECE may record a different dimension compared to how it was organised and run previously. Furthermore, progression of children from ECE to grade 1 is likely to bring desirables results as children are likely to make a transition within the same social environment.

Research has also, however, revealed that in Zambia, attempts to expand ECE "may be premature and potentially damaging to an already tenuous education system" (Thomas & Thomas, 2009:6). As children enter their first grade, they do so with no common ground as some would have been to preschools, while other would have not. The situation becomes more compounded as children's first school environments also differ from each other. It is possible that any given learning environment in which the child finds himself may provide better or worse opportunities for developing literacy and numeracy. An interplay of such factors place children in Zambian primary schools at an advantage or risk of either progressing or lagging behind academically in school.

It is also worth noting that most Zambian families' living circumstances are characterized by low socioeconomic status and poverty, a situation which can affect children's health, psychopathy and intelligence. Illiteracy at family level may also be associated with the low socioeconomic status. Lack of employment, nutritious food and good sanitation can also contribute to poor parenting as a good number of parents and caregivers would have very little or no quality time for their children. Coupled with inherited characteristics, the home environment to a greater extent regulates a child's learning behavior and capacities. It is possible that the school context can influence the behavior of the child, but not all children would completely and always be influenced by the school. This is so because children are different but as such they response to the same environmental circumstances differently. The current research, therefore, helped to substantiate such connections among child susceptibility factors, the home literacy situation, quality of instructions and grade one pupils' skill-attainment in literacy and numeracy in Zambian government primary schools.

1.2 Statement of the problem

Despite innovations implemented in the last decennium, particularly the Primary Reading Programme (PRP) which was aimed at improving basic literacy levels at primary level in Zambian government primary schools, many grade one children still fail to acquire grade-level literacy as well as numeracy skills. Not long ago the language of instruction in teaching literacy was changed from English to local and familiar language, but to no meaningful improvement at all of literacy levels (Kelly, 2000). In addition, Chansa-Kabali (2014) notes that the government and other stakeholders have invested both efforts and resources in the acquisition of reading in children. These efforts seem to focus so much on literacy excluding numeracy, but the two academic skills are equally essential and do not develop separately. Notwithstanding all efforts, Zambia continues to record low levels of literacy achievement among children and high illiteracy among adults (Hambaba, 2008). This situation strongly suggests that there are a number of unknown critical underlying factors responsible for this persistent poor performance. The situation, therefore, calls for thorough investigations without which children in early grades will continue to struggle with low literacy and numeracy skill-attainment. Regarding the actual cause of poor performance among young children in Zambia, Matafwali (2010) argues that there is no empirical evidence to establish the causal factors underlying the persistent reading failure among many Zambian children given the rich literacy programme in place. Available research evidence also clearly indicates that numeracy has not attracted as much research attention as literacy, suggesting the need for comparative studies in both early literacy and numeracy. The main concern also is, if children in the foundational years fail to acquire grade-appropriate initial literacy and numeracy skills, their academic progression in consecutive schooling-years would be at a great risk and in due course, such a risk would transcend into low quality of education in the nation. Furthermore, later in their life, people would not exhibit functional literacy and numeracy skills and as such, their contribution to national development would be negatively affected. This study, therefore, sought to establish the differential effects of child characteristics, home factors and school quality on young learners' literacy and numeracy skill-attainment with the view to improve the teaching and learning of early literacy in Zambia.

1.3 Purpose of the study

The purpose of this research was to establish differential effects of child and family characteristics which seem to have bearing influence on early literacy and numeracy skill attainment among grade one pupils at selected low and high performing government primary schools. Aim of this study was to identify risk as well as enabling factors for academic performance by comparing low and high performing schools. The study further attempted to suggest appropriate corrective interventions regarding the prevailing low literacy and numeracy skill-levels among young learners as these are critical academic and functional skills in one life.

1.4 Objectives of the study

This study was guided by the following objectives:

(a) To identify child risk factors leading to pupils' poor performance in literacy and numeracy skills in grade one.

(b) To identify environmental (home and school) factors which hinder children's success rate in early literacy and numeracy skills.

(c) To determine which schools increase the success rate of vulnerable children taking into account specific dimensions of child as well as family-factors.

(d) To propose alternative literacy and numeracy instructional and home learning support practices in order to equip grade one teachers with better literacy and numeracy teaching skills and attitudes.

1.5 Main research question

Why do most young learners in government primary schools fail to acquire and attain appropriate grade-level literacy and numeracy skills despite efforts by the Ministry of Education, Science, Vocational Training and Early Education undertaken to improve the teaching and learning of these skills?

1.6 Hypotheses of the study

This study was based on the following hypotheses:

(a) Children from families with high home literacy levels do better in early literacy and numeracy than those children from families with very low home literacy levels and support systems.

(b) Low socioeconomic status (SES) at home where young children come from lead to failure to acquire acceptable literacy and numeracy skills in grade one.

(c) Children who are easily stressed and go to schools with weak didactics fail to attain grade-level basic literacy and numeracy skills, but do better in schools with strong didactics.

(d) Children's executive functioning influence literacy and numeracy performance among children at both low and high performing schools.

1.7 Theoretical frame work

This study was informed by the Differential Susceptibility Theory. This theory converges on the hypothesis that some individuals are more susceptible than others to both negative (risky-promoting) and positive (development-enhancing) environmental conditions. The Differential Susceptibility Theory has far reaching implications for understanding whether and how much child development responds for better and for worse to environmental and biological conditions.

Regarding the Differential Susceptibility Theory, research so far demonstrates that exposure to environmental adversity places children and adults at elevated risk for developing cognitive, social, emotional and health problems (Boyce, (2007); Luthar, (1999); McLoyd, (1998); Shonkoff, Boyce and McEwen, (2009)). Children are at double-risk due to poor teaching as a poor teaching environment enhances their learning problems. There is new evidence for the hypothesis that the very characteristics of individuals that make them disproportionately vulnerable to adversity sometimes also make them benefit disproportionately from contextual support (Bakermans-Kranenburg & van IJzendoorn, 2007; Kegel, Bus, & van IJzendoorn, 2011; Van der Kooy-Hofland et al., 2011).

Boyce and colleagues have proposed a new theory suggesting that stress reactivity is better conceptualized as a high biological sensitivity to context (Boyce, 2007; Boyce & Ellis, 2005). From this theoretical perspective, children with heightened biological sensitivity to context are predicted to be more vulnerable to negative and stressful contextual factors, but also to have greater capacity to benefit from positive environmental influences. Thus, high biological sensitivity may be maladaptive in the context of adversity but adaptive in the context of a nurturing and supportive environment (Boyce, 1996; Boyce et al., 1995; Boyce et al., 2006). This work underlines the importance of understanding more fully the biological processes that interact with environmental influences to shape children's adaptation, as indexed by competence and psychopathology (Curtis & Cicchetti, 2003; Masten & Obradovic´, 2006).

In this line of argumentation, some vulnerable children may achieve exceptionally well in a more promising school environment, while other children who are less vulnerable may not suffer from poor school environments.

1.8 Significance of the study

It was hoped that this study would generate information on the role played by child and family characteristics, home literacy, home learning-support and pedagogical practices as determining factors of early literacy and numeracy skill-attainment. Certainly, such information would be helpful to teachers, curriculum designers and researchers in early literacy and numeracy in that it would inform them to devise more beneficial instructional interventions. Parents/caregivers of children would find this information valuable for them to give the best learner-support at home. Consequently, children's literacy and numeracy skill-attainment would be improved right from the foundational stage, thereby optimizing their academic progression in both their current and later school years.

1.9 Ethical considerations

This research was purely for academic purposes. Therefore, the involvement of all pupils, teachers and caregivers was done with total observance of informed consent and high confidentiality of the information they provided. Among keys aspects of concern, all details of identity such as names of participants remained anonymous. Secondly, before engaging anyone in the study, informed consent, preferably in writing, was sought. For grade one pupils, this was done in consultation with their parents or care givers. Most importantly, the research proposal for this study passed through one of the University of Zambia Research and Ethics Committees (UNZAREC) and secondly the Ministry of Health Headquarters for guidance and approval before proceeding for data collection and other preliminary processes. Therefore, the researcher adhered to all research ethics.

1.10 Limitations of the study

(a) The selection of participating schools was based on Grade 7 and 9 national examination results obtained from the Examinations Council of Zambia (ECZ). There seems to exist a huge grade-gap between the grades that were used as the selection criterion and grade ones upon which the research was conducted.

(b) The actual classroom teaching climate was not included as a source of data. Observing teachers teach and interact with their learners could have enriched the study to see the influence of classroom practices which was presumed to have some effect on learner performance as teacher-performance in class would have been interesting to examine as well.

1.11 Definition of terms

Alphabet knowledge: ability to demonstrate familiarity with letter-names and letter-sounds.

Audio-lingual: an old language teaching approach which emphasized language form rather than its use.

Childhood: a person's state of being child.

Consensus: general agreement on something between or among people.

Curriculum: the subjects comprising a course of study in a school, college or university.

Developmental trajectories: forces or factors shaping various types of development.

Decennium: relating to a period lasting or recurring every ten years.

Differential: dependency on a difference or varying according to circumstances or relevant factors.

Double-risk: having two risks from two different sides.

Dyslexia: a disorder involving difficulty in learning to read or interpret words, letters and other symbols, not related to low IQ .

Executive functions: organized skills which facilitate the performance of certain academic tasks.

Home language: language mostly used in the home.

Home literacy practice: activities in the home that build on the child's language and literacy skills.

Intra-class correlations: a measure of intercoder reliability.

Language of instruction: a medium of instruction used for teaching purposes.

Language policy: official guidelines for the use of a language in teaching or official communication.

Literacy: the ability to read and write.

Multiple-intelligence: a view of intelligence involving several factors as opposed to a single factor.

Numeracy: an academic skill relating to the knowledge of numbers.

Parental involvement: giving parents of children opportunity to participate in or have a say in their children's school-related activities.

Pedagogical didactics: manner of a teacher, especially so as to be patronizing.

Phonemic awareness: ability to recognise that a spoken word consists of smaller (sound) units.

Phonics: a method of teaching people to read by correlating sounds with alphabetic symbols.

Phonological knowledge: to be aware of the relationships of sounds within or between languages.

Play language: language mostly used when the child plays with friends.

Poverty: the state of being without resources for decent living and survival.

Precursor: a thing that comes before another of the same kind.

Pre-service: usually first training pursued before someone starts employment.

Kindergarten: an equivalent of a nursery school or preschool.

Kurtosis: the peakness of a statistical distribution.

Reading: the ability to decode unfamiliar words and the ability to read fluently.

School readiness is a multidimensional construct that includes behavioral, emotional, cognitive, and knowledge components that make the child ‘‘ready to learn’’ at school entry.

Skewness: asymmetrical statistical distribution.

Stress reactivity: a response to some psychological and physiological or biological stress stimulus.

Susceptibility: the state or fact of being susceptible to the environment relating to a person's temperament or constitution.

Working memory: a person’s short-term memory.

1.12 Summary

The goal of this chapter has been to provide the study general overview. Background of key issues regarding low literacy and numeracy levels in Zambian primary schools and other countries have been highlighted. Arising from the Zambian studies, there is sufficient evidence to suggest that young children perform below grade level and a number of child characteristics, (child, home and school factors) seem to be associated with this level of performance. It is also clear that a lot of research has been underway aimed at addressing the low literacy levels in Zambia, but children’s performance still lag behind. The importance of literacy and numeracy skills attainment cannot be over emphasized. In this vein, Matafwali, (2010) argues that in a technological era like ours, the demands for higher literacy levels or competencies are ever increasing creating more grievous consequences for those who fall short. It is in this respect that investigations that document early literacy development and other critical indicators in foundational academic skills learning and teaching become essential. Compared to research in early literacy, lesser efforts seem to have been dedicated to early numeracy, a situation which motivated the researcher to include doth early literacy and numeracy in this study.

In Zambian schools, an interplay of factors, rather than a single factor might be responsible for children's persistent low skill-attainment in literacy and numeracy skills. In the current study, several child characteristics, home-situations and school factors have been brought out as the main determinants of children's performance. It was also necessary to find out how these factors do not influence children in exactly the same way as children differ in many respects even if they are raised in the same home and educated in the same school environment and by the same teacher. Target factors which seem to influence children's learning include: physiological reactivity, motivation, opportunities at home, support at home, availability of literature materials at home and many more.

CHAPTER TWO
2.0 LITERATURE REVIEW

2.1 Overview

The first part of this chapter discusses literacy and numeracy development. Later a number of characteristics which seem to be predictive have also been cited. These include: child characteristics with specific reference to neurobiological stress, child home-foundation, executive functions and intelligence. In addition, home factors discussed include: the home environments, parents socio-economic status (SES), and parental involvement as directly or indirectly relating to children's performance. Motivation and learning, teacher-competence and teaching quality have been outlined although the study did not focus so much on the teacher-in-put. In addition, significant research studies that have attempted to determine the strength of child and family characteristics in determining a child reading, writing and numeracy performance have been referred to as well.

2.2 Literacy and numeracy development

2.2.1 Literacy development

The term literacy denotes two skills; reading and writing. According to (Paris, 2005), learning to read is one of the greatest accomplishments in childhood because it is the foundation for learning and academic achievement later in someone's life. Reading as a component of literacy involves two basic processes, decoding and a comprehension process. The decoding process involves understanding the relationship between letters and symbols which is similar to oral language and this enables the learner to pronounce words correctly.

In line with one of the expectations in this study, The National Reading Panel (2000) states that reading is influenced by a number of interacting factors. One of these factors is phonological awareness which is awareness of phonological units represented by a given writing system which is positively correlated with reading ability. In addition, Elbro, Bostron and Peterson (1998) has also revealed that phonological awareness follows a developmental schedule, with awareness of syllables developing before awareness onset which in turn develops awareness of phonemes. This awareness of phones and the ability to reflect on and manipulate them increases the chances that young children will develop good decoding skills leading to success at reading from early grades.

Noe et al (2012), however, note that despite attendance in preschool and the potential of emergent literacy skills to build a foundation for reading, many children do not receive sufficient emergent literacy instruction early enough. On the other hand, it further argued that a spoken language does not require a conscious awareness of the speech sounds in words. Speech is produced and understood automatically, with little conscious attention given to sounds. However, phonological awareness (PA) is the conscious awareness of sounds of a language. It is the ability to reflect on the sounds of words separately from the meaning words. It is one of the major emergent literacy skills, which is most strongly related to future reading (Adams, 1990; Ezell & Justice, 2005; Lonigan et al., 2000). PA can also be described as children's ability to attend to the auditory aspects of language, without attending to meaning (Koutsoftas, Harmon, & Gray, 2009; Trehearne, Williams, & Moore, 2003). PA involves a metalinguistic understanding of the structure of oral language, including the ability to recognize and manipulate parts of oral language, that is, sentences, words, syllables, and phonemes (Adams, 1990). The National Reading Panel (2000) describes beginning reading as a developmental skill which depends on phonological awareness, i.e., understanding that phonological units in words represent letters. This awareness of phonemes and the ability to reflect on and manipulate them increases the chances that young children will develop good decoding skills leading to success in reading in early grades.

Research has established several findings to substantiate why some children have difficulties learning to read. In this regard, a number of reasons for the possible occurrence of reading difficulties have been raised. Evidence shows that poor instruction and literacy experience (Pressley, 2006; Vellutino, et al., 1996) and biological disorders such as dyslexia (Gillon, 2004; Pressley, 2006; Shaywitz, Morris, & Shaywitz, 2008), lead to difficulties in learning to read, but perhaps most significant are phonological awareness and alphabet knowledge play in reading difficulties.

Ziegler and Goswami (2005) hold the view that the development of reading depends on phonological awareness across all languages so far studied. However, it is acknowledged that languages vary in terms of their consistence with which phonology is represented in orthography.

In terms of how reading starts and develops, different scholars and researchers continue to raise various views pertaining to it. For example, Crystal (1996), states that reading takes place letter by letter with large units gradually being built. In the same vein, Hill (1997) observes that the connectionist perspective places priority on learning the code as means to fluent reading and increased comprehension. This approach is closely linked to the developmental readiness perspective where knowledge is based on elements or pieces that are then put together or connected to make a whole. The view cited above, therefore, implies that learning to read is a process associated with a number of smaller steps skills. Adams (1990) adds that one of the best predictors of how well students will learn to read during their first two years of school is phonemic awareness. These views are in line with what was anticipated in this study where alphabet knowledge, phonemic awareness and reading and writing are among the main aspects of focus.

Research has consistently pointed to predictive role of phonological awareness and literacy skills.The importance of phonological awareness as a central precursor for later developing reading skills is widely accepted (Goswami and Bryant, 1999). In a quantitative meta-analysis of experimental training studies of phonological awareness, Bus and van IJzendoorn (1999) showed that phonological training reliably enhances both phonological and reading skills. They also concluded that gains produced by means of phonological training are more robust and consistent when phonological awareness and letter-sound correspondence are taught together, claiming that the letters may draw the child's attention to the sounds of spoken words and the visual symbols anchor the phonemes perceptually.

Manning and Kato (2012) have also explained that phonemic awareness is when you hear a word and can divide it into the smallest parts. Phonics on the hand is when you are looking at the letters in a word and you make sound-symbol correspondence. However, not all children become phonemically aware at the same age or grade. Some 4-year-olds can segment multi-syllabic words, into syllables and some 6-year-olds cannot segment a one-syllable word phonemes. Students who have difficult learning to read in the early grades are often unable to do activities related to phonemic awareness and those with poor phonemic awareness skills at the end of their kindergarten year are more likely to become poor readers than those with well-developed phonemic awareness skills.

Regarding writing, Dixon and Nessel (1983), state that it is generally accepted that writing is more difficult than reading. Producing meaning in writing requires more effort than recognizing meaning through speaking or reading. What can be said aloud cannot be expressed as easily or quickly in writing. It is also possible to say that when deciding what to say, learners must follow the conversions of spelling and pronunciation that will make the message understandable to others.

Mercer and Mercer (1993) noted that writing is both a skill and a means of self-expression. The writing skills also integrate and depend on visual, motor and conceptual abilities. Young writers take several years to develop this ability. With reference to its complexity, Crystal (1996) argues that to write is to plan and produce language so that it can be read. Even at a tender age, children who try to complete writing assignments demonstrate an ability to think. To develop good writers, we must provide learners with a structure that will produce the right sequence of progressively more complex actions.

Shaywitz (1998) and Snowling (2000) state that remarkably individuals with dyslexia often have associated difficulties with writing, spellings, motor co-ordination and attention abilities, which vary across individuals making it difficult to specify the etiology. Some children write as confidently and as enthusiastically as they did in the first language. For some children, however, writing becomes a dreaded, anxious activity, as they wrestle for perfection with pencil strokes, word-spellings and stray marks resulting in children discarding the work and beginning a new. The challenge of learning to read and write in two orthographies simultaneously or immediately one after the other is even greater as the acquisition of these skills entails learning new phonological information and the ability to reliably assign this information to the appropriate graphic representation.

"For some children, literacy development does go very badly , leading to persistent, pervasive and qualitatively different progress in cognitive development by comparison with normal children. Such atypical development can have many different causes, but generally has some sort of physiological basis" (Wolf et al., 1990: 347),which can be described as stress reactivity because experiences either at home or school can induce children's emotional reactions. These reactions can affect how the child acts and reacts to learning situations. Wolff et al (ibid) further observe that recent research on individual differences in mental ability suggests that the way the mind develops is the product of a complex interaction between biological factors (genetic temperament and neurological characteristics) and social factors (determining the way of conceptualizing the world, the skills and expertise, the style of response or attitudes to problem solving that is transmitted to the child from his or her family and surrounding culture).

Since the process of literacy development takes the general pattern of cognitive developments, Cox (2001) reveals that children's thinking develops in a clear sequence, though it is not necessarily assumed that there are discrete stages in this development. Case (1978) further states that cognitive development is sequential, becoming more proficient at processing information. Another proposition relates to working memory in which it is argued that development is explained in terms of mental space, the increasing size of working memory as the child develops. Children certainly become more efficient at processing information as they get older. For other children, however, Pressley (2002) argues that lack of phonemic awareness seems part of the vicious circle. Children who are exposed to a great deal of language and have well developed vocabularies early in life have greater phonemic awareness. Goswami, (2000, 2001) and Metsala (1999) in Pressley (2002) argue that a well-developed vocabulary provides many opportunities to discriminate words on the basis of sound differences.

As children are growing, Costa (2001) argues that thinking and reading develop along parallel trajectories. It is also expected that as children develop literacy skills, mathematics skills are also emerging. Recent research suggests that instructional methods and materials in literature classes can become the perfect vehicle to teach higher level thinking. Through literature, students come face to face with powerful thinkers who influence their thinking too. On the hand, Kirk et al (2012) observe that because reading and arithmetic are similar in many ways (for example, numbers and words stand for concepts), a child with language difficulty is likely to have difficulty in learning to calculate. In Zambia, however, more research conducted in Zambia so far has a biased concentration on literacy development as compared to what has been done in the area of numeracy.

Studies conducted so far view literacy development not to occur in a vacuum as language plays a crucial role in this process. Matafwali (2010) among other scholars observes that using the mother tongue facilitates children’s thinking and development of concepts that enable them to easily acquire knowledge as well as vocabulary in second or third languages. A mother tongue is a language a learner needs to rely on as an emergent reader in the first grade, but literacy proficiency in English is the ultimate goal.

Phonological awareness in a target language (mother tongue or second language) is a precursor to reading development as it follows a developmental schedule of syllables developing before awareness of phonemes. Presley (2002) states that phonemic awareness can be developed through systematic practice in categorizing words on the basis of common beginning, middle and end sounds.

In another way, Moats (2000) states that to learn to read and spell using phonics, children have to learn the relationship between letters (graphemes) and sounds (phonemes) and then remember the exact letter patterns and sequences that represent various speech sounds. At this stage, to be an independent reader, the child relies heavily on the support of the adult to help him develop perceptions and interpretations. Therefore, the presence of more skilled adults, peers and siblings in the child’s home or school environment facilitates reading attainment with ease.

Domblewski and Kauffman (1990:21) noted that “parents serve as their children’s first and most important teachers and role models. Creating a learning environment and atmosphere in the home in which learning can take place is one of the major responsibilities of care givers. Such an atmosphere is marked by parents’ or care givers’ willingness to assist the child. They can also nurture a child’s mental development by seeing to it that the baby experiences a variety of stimulating experiences in the surrounding’’.

Regarding what happens before reading instructions, Pressley (2002:90) argues that much of what is relevant to the development of literacy occurs before the child first passes through the school-house door. Some researchers have argued that opportunities and events in the home such as game and play activities, interactions during meal times, media viewed by children and parents, outings, reading, writing and drawing have implications for literacy development. Presley (ibid) further argues that literacy researchers studying the preschool years have been much influenced by developmental psychology which deals with attachment and how the development of a secure attachment is critical to productive cognitive interactions between parents and children.

Since literacy takes long to be well developed, young learners need a stable early, consistent and well supported start. Presley (2002:91) argues that ‘‘ when parent-infant interactions go well, babies form strong emotional ties with their care-givers, who become the primary adult attachment objects. This is important for emotional and other forms of development. The more secure the attachment, the effective the parent is in helping the child to explore the world.

With regards to literacy development, Teale & Sulzby (1986) state that the movement from emergent to conventional literacy is a gradual process. It should also be realized that these two forms of literacy are not discrete stages, but a continuum of learning that varies with the complexity of each individual's development. Children move into different periods of development in their efforts to become successful readers, just as they did at the emergent level. Preschool is a critical time for the development of foundational language and literacy skills, including oral language and vocabulary, phonological awareness, alphabet knowledge, and conventions of print (Bowman, Donovan, & Burns, 2000; Welsch, Sullivan, & Justice, 2003). Presley (2002) further argues that when phonemic awareness instruction is added to an educational environment in which little skills instruction is occurring, there are clear benefits for the students receiving it. However, many kindergarten and grade1 children lack the awareness that words are streams of sounds that can be disentangled and that sounds can be assembled to produce words. Fortunately, phonemic awareness can be developed through instruction, with clear benefits to subsequent acquisition of reading skills.

In the same vein, (Cox 2001:461) holds the view that ‘developmental theorists propose that development is sequential as it is related to an increase in working memory. As they get older children become faster at processing information and increasingly able to apply rules. However, there are individual differences in the use of information processing strategies which may be related to intelligence’.

From studies undertaken in Zambia and elsewhere, it is important for educators to realize that literacy development is quite demanding on the part of both the teacher and the learner. From the learner’s perspective, Ferreiro and Teberosky (1982) argue that the young child’s concept of words changes as the child’s literacy development evolves. Children’s ideas about words are quite different from adults’ concepts because a child constructs and develops their own knowledge and this is often quite different from that of an adult, thus, there are differences between how an adult and a child understand reading and writing. Cox (2001:445) notes that “children’s thinking differs in many ways from that of an adult, as shown in their beliefs, their understanding of the physical world.” Piaget, a constructionist theorist believed that children’s thinking goes through changes at each of the four stages of development until they can think and reason as an adult. He also introduced the idea of decalage, the gradual acquisition of particular skills within a particular stage of cognitive development.” Likewise, literacy being a gradual and complex process does not emerge and develop independently. Though most studies focus more attention on literacy development alone, with so few on mathematics, it is important to address early literacy and numeracy skills together.

Because reading and writing are thinking processes, Allington and Cunningham (1996) and McGee and Richgels (1996) observed that emergent literacy must also be considered in the context of children’s developing cognitive skills. In this regard, the cognitive and socio-cultural theories of Piaget and Vygostky respectively are necessary to the discussion and study of early literacy and the factors that facilitate it. In view of this, the current study also considered that development of numeracy development as part of the developmental process.

The presence of adults and siblings in most Zambian families sets a social environment that provides academic benefits as well. Cunningham and Zibulsky (2014: 256) indicate that ‘‘adults can help foster children inference-making skills well before they are required to make these strategies as independent readers. After your child begins to read on his own, it would be important for him to continue working on these advanced skills.” They further observe that preschool children are capable of interacting with text beyond literal level, but many only do so when prompted or questioned. This is highly dependent on social interactions in the home and the Zambian early literacy situation for children in preschools may not be in line with this assertion.

Presley (2002) records that Bus and van IJzendoorn (1995) studied a group of 3 year-olds who varied in security of their attachment with their mothers with findings that the frequency of reading that mothers reported doing with their children was related to security of attachment. This simply means security in attachment predicts healthy interactions as parents and children tackle intellectual challenges together, including reading with one another. Apart from reading for and with children, parents also need to do some mathematical sums with their children.

2.2.2 Numeracy development

Mathematical concept formation is believed to involve an active process on the part of the learner. It involves the construction of meaning. Therefore, the curriculum is not that which is learned, but a programme of learning tasks, materials and resources from which learners construct their knowledge.

It should also be made clear that this learning takes off within the environment where early numeracy skills in foundation years is preceded by activities such as oral counting using concrete objects, sorting, matching, jigsaws, drawing, copying and model construction (Gelman & Gallistel, 1978). At this stage, the play method, the use of songs and rhymes are useful ways of presenting mathematical concepts in a relaxed and enjoyable manner. Through sand play, water play, artcraft activities, plasticine, play with blocks, string, and other things provides a rich environment in which the child acquires, in an informal but very important way, the beginning of understanding of number, measurement and spatial concepts. In Zambian preschool and primary schools, teachers use such methods of teaching which children enjoy a lot both in class and outside class during play time. It is, therefore, highly expected children's performance in numeracy should be that low. Teachers too are expected to teach mathematics with ease.

The counting component is related to simple computation, whereas quantity discrimination is linked to the use of a mental number line. The ability to use a mental number line appears to be dependent on a potentially inherent magnitude representational system (Feigenson, Dehaene, & Spelke, 2004). The use of counting to determine exact quantities is considered to be another fundamental enumeration ability (Gelman & Gallistel, 1978). Its development starts at the age of about 2 or 3, when children begin to count, mostly asynchronously. They begin to realize that numbers can be used to count objects. At this age, children can connect the concept that counting determines numerosity to all numbers within their counting range. At the age of 5, children reach the stage of resultative counting. This means that they are becoming aware of the fact that counting has to begin with the number one, that every object has to be counted once, and that the last number gives the total amount of objects. This cardinality principle is very important in understanding counting).

It was anticipated in this study that children may differ in academic skill-performance due to a number of factors. Research has revealed that about 5-10% of children have serious difficulties with the acquisition of these counting skills in kindergarten. These children are at risk for later math learning disabilities (Aunio, Hautamäki, & Van Luit, 2005; Kavkler, Tancig, & Magajna, 2003), as recent research has indicated that counting is an important precursor of later math abilities (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004).

Another important factor may be formed by deficits in children's executive functions, as several studies have found children with math learning disabilities to perform significantly below their peers without disabilities on tasks that measure executive functioning (e.g., Bull & Scerif, 2001; Gathercole, Pickering, Knight, & Stegmann, 2004). There is also empirical evidence suggesting that executive functions are already involved in learning early numeracy (Goodyear & Hynd, 1992). In a study by Braunmiller (2008) executive functioning emerged as a significant contributor to arithmetic calculation. Second, after controlling for reading, processing speed, short-term memory, and executive functioning, only visual-spatial working memory, and not verbal working memory contributed to arithmetic calculation. In the current study, executive functions were expected to predict both literacy and numeracy skills among Zambian children in the first grade.

From the very beginning, therefore, children need considerable exposure, practice and experience of working with concrete objects physically so that before they start learning facts in a systematic way such as addition, they have a clear idea of what is involved. The small objects of practice may include cubes, counters, buttons, beads, toy cars, toy animals and also children themselves. So both the home and school environments need to be enriched with such materials, some of which can be bought or improvised.

The general cognitive development as highlighted by Kassin (2001) rests on the assumption that children are curious, active and constructive thinkers. According to Piaget, infants and children form schemas or mental representations of the world in order to make sense of it. Through a process of assimilation, he said, children try to put new information into existing schemas through the process of accommodation. Viewed in this way, literacy and numeracy development occur through a complex interplay between pre-existing knowledge and new information gathered later on. According to Piaget's perspective, children construct their own ideas as they actively participate in and manipulate various activities in the environment which need to suit their mental age as well as need to be interesting. Vygostky's perspective on the other hand suggests that emergent literacy is also based on behaviours modeled and supported by adults who encourage children to change and refine their own ideas to more conventional and age appropriate notions.

Mercer and Mercer (1993) argue that Mathematics has a long structure. Students first construct simple relationships and then progress to more complex tasks. During the pre-school and primary years, many young children are not able to sort objects by size, match objects and understand the language of arithmetic, or grasp the concept of rational counting. Learners with math deficiencies are as disabled as individuals who are unable to read and math deficiencies are common at all age levels. Mercer and Mercer (1993:236) further inform that 'daily living requires numerous math skills; for example, planning, computing percentages for purchases or tips, making estimation, interpreting recipe measurements, measurement for cooking, etc. Moreover, in school settings failure in math-areas seem to generate high levels of anxiety. Learners with math deficiencies are as disabled as individuals who are unable to read and math deficiencies are common at all age levels. During the pre-school and primary years, many young children are not able to sort objects by size, match objects, understand the language of arithmetic, or grasp the concept of rational counting.

In most Zambian government primary schools, many children fail to acquire basic numeracy skills although the failure rate is unknown. This failure persists on till later stages in secondary and tertiary education thereby making mathematics an unpopular subject. These difficulties can be attributed to environmental factors, such as socioeconomic status or parental stimulation, experience with different kinds of materials (e.g., Arnold & Doctoroff, 2003), and child variables such as number-sense, intelligence, or other domain-general functions.

Central to raising learner achievement in mathematics is improving the quality of mathematics teaching. In addition, recent studies indicate that domain-general cognitive abilities, more specifically executive functions, may provide good explanations for variability in early math learning (e.g., Bull & Scerif, 2001; Espy et al., 2004; Kroesbergen, Van de Rijt, & Van Luit, 2007; Passolunghi, Vercelloni, & Schadee, 2007). Learners who receive high-quality instruction experience greater and more persistent achievement gains than their peers who receive lower-quality instruction (Rivkin, Hanushek, & Kain, 2005; Wright, Horn, & Sanders, 1997). Rivkin et al. (2005) found that learners who were taught by a highly effective teacher achieved a gain of 1.5 grade equivalents during a single academic year, whereas learners enrolled in classes taught by ineffective teachers gained only 0.5 grade equivalents in the same year.

Moreover, the effects of high-quality instruction on the academic achievement of disadvantaged learners are substantial enough to counteract the host of familial and social conditions often found to impede learner achievement (Rivkin et al., 2005). Put differently, teachers are critical determinants of learner learning and educational progress and thus must be well trained to use effective teaching practices. Suffice also to note that researchers' attention for early numeracy has grown in the past decade, in the area of both assessment and instruction. Adequate mastery of this skill will enhance the development of mathematical knowledge in later grades, when children receive their first formal math instruction. (Berch, 2005; Jordan, Kaplan, Locuniak, & Ramineni, 2007).

2.3 Child characteristics

In the context of this study, child characteristics represent a hoist of qualities and behaviors that are part of a child's temperament, personality and abilities which are of great importance to literacy and numeracy skill-development. These include learning behaviour, pupil's age, nutrition, health, intelligence, pre-school background, home background, socio-economic status and motivation among others. These characteristics will be of focus in this study because in isolation or in combination they impact children's performance in early literacy and numeracy either positively or negatively.

2.3.1 Executive functions and learning behavior

In this study executive functions are among target predictors of literacy and numeracy skills attainment because research has shown that executive functions are a set of cognitive abilities that control and regulate behavior that is required for learning. These include: working memory, inhibitory skills and attention (Diamond et al, 2007). These skills cover basic cognitive processes that organize thought resources towards a desired condition and preschool and foundational years of schooling seem to be an important time for the development of executive functions. Kroesbergen et al (2009) argue that *executive function* is an umbrella term for different higher order functions, such as planning, inhibition, and updating, and executive functions are necessary for the adequate execution of complex goal-directed activities, such as mathematical tasks (Welsh et al, 2003). Executive functions are especially important in novel situations in which one cannot rely on routine and have in common the regulation of other cognitive skills. Learning behavior in its active form depends on psychological skills which include attention, inhibition and working memory. Kassin (2001:131) states that, "attention is a state of awareness consisting of the sensation, thoughts, feelings that one is attending to something at a given moment." Executive function skills are supposed to be stimulated in preschool and elementary grades as teachers are expected to teach activities which stimulate executive function skills such as attention, working memory and inhibition skills (Diamond et al., (2007) which are associated with school readiness, turn-taking and paying attention.

Individual differences among children predispose children to risky and beneficial experiences. Those who most need improvement benefit the most from available learning experiences. Children with the weakest executive functions benefit the most from any executive function intervention or program (Flook et al., 2010; Karbach & Kray, 2009; Lakes & Hoyt, 2004). Hence, early Executive Function training should be an excellent tool for leveling the playing field and reducing social disparities in Executive Functions, thus heading off social disparities in academic achievement (O'Shaughnessy et al., 2003). Because executive functions predict school readiness (Blair & Razza, 2007), later academic performance (Raver et al., 2011; Li-Grining, Raver, & Pess, 2011), and mental and physical health (Moffitt et al., 2011), if the early disparity in executive functions is narrowed, the disparity in school readiness and academic and health outcomes should be narrowed as well.

Children's executive functions should be challenged throughout training. executive function demands need to keep increasing as children's executive functions improve, or few gains will be seen (Bergman-Nutley et al., 2011; Holmes et al., 2009; Klingberg et al., 2005). There may be two reasons for this. First, if people don't keep pushing themselves to do better, they stop improving. Second, if the difficulty of an activity doesn't increase, it becomes boring, and children lose interest. Clearly, Executive Functions can be improved in children, even in those as young as 4 or 5 years of age, without specialists and even without computers. To improve Executive Functions, focusing narrowly on them may be less effective than also addressing emotional and social development.

Attention is a cognitive process of selectively concentrating on one aspect in the environment while ignoring other things. Attention has also been referred to as the allocation of processing resources. It is, therefore, a very important child-characteristic in as far as learning academic and other skills is concerned. This so because learning a concept is achieved by information being perceived, stored in the short term memory before being passed on in the long term memory where it is stored for a long time. To perceive any form of stimulus, the learner is supposed to pay particular attention to that. A stimulus does not present itself in isolation, but it exists mostly with other distracters. Santrock (2004) argues that selective attention involves focusing one specific experience while ignoring others. Young learners are strongly influenced by the features of the task that stand out. Executive functions develop rapidly during childhood, with substantial changes occurring between 3 and 5 years (Müller, et al, 2006). After the age of 6 or 7, children more efficiently attend to the relevant dimensions of the task or the problem. Developmentalists believe that this change reflects a shift to cognitive control to attention, so that children act less impulsively and reflect more. Examples of attention include listening carefully to what someone is saying while ignoring other conversations in a room (the cocktail party effect) or listening to a cell phone conversation while driving a car.

Self-regulation positively affects a student’s ability to learn by promoting social competence, academic achievement, goal-directed behaviors, and emotional states (Buckner, Mezzacappa, & Beardslee, 2009). More specifically, it comprises “cognitive, evaluative, and behavioral processes that guide goal-directed action and emotional responsiveness” (Rudolph, et al, 2001). In the classroom, self-regulated behaviors are critical to student learning because they enable self-sustained efforts toward achieving a teacher’s instructional goals. Over time, a self-regulated learner has a greater chance of acquiring new academic skills as a result of shared learning goals that bring about purposeful actions before, during, and after instructional activities within a lesson.

Undoubtedly, there are many facets to “self-regulation.” Borrowing from the executive functioning literature, there is need to focus on the construct of selective attention, which is particularly useful for understanding how mechanisms of controlled attention might support learning (Rueda, Posner, & Rothbart, 2005). For example, selective attention is theorized to allow for “efficient and focused processing of goal-relevant stimuli, with minimal intrusions from goal-irrelevant stimuli” (Lavie, 2000, p. 175). In other words, this type of focus could benefit young learners as they begin to acquire reading skills because it would guide these learners toward engagement with literacy instruction provided and away from distractions caused by other elements present within the classroom environment. Moreover, it would serve to structure classroom learning opportunities by enabling students to identify and distinguish between relevant and irrelevant information, sustain focus, and resist forgetting. The classroom is a complex learning environment, encompassing teacher-level characteristics (e.g., teacher experience, knowledge, and skills; Cunningham, Zibulsky, Stanovich, & Stanovich, 2009), student-level characteristics (e.g., prior knowledge, cognitive processing constraints, motivation; Verhoeven, Schnotz, & Paas, 2009), and their interaction (e.g., Connor, Morrison, et al., 2009). Attention behaviors, as rated by teachers and mothers, is one of the strongest predictors of reading performance, following reading and math skills at school entry (Duncan et al., 2007).

For example, the regulation of attention-memory is likely important for acquiring academic skills because it supports the working memory processing needed for complex task performance by keeping information current in mind (Garon et al., 2008; Gathercole et al., 2008; van der Sluis, de Jong, & van der Leij, 2007). That is, in a kindergarten classroom, this capability may allow a student to remember multistep directions by allowing him or her to hold task-relevant steps in mind and disregard other, irrelevant information. This would also serve to foster sustained task focus and resistance to forgetting during instruction.

Inhibition could be described as “the ability to ignore distraction and stay focused, and to resist making one response and instead make another. Working memory is defined as “the ability to hold information in mind and manipulate it”. The last function, attention is identified as “the ability to flexibly switch perspectives, focus of attention, or response mapping (Diamond, 2007:70).”

Inhibition is associated with distraction which is based on the assumption that, during the performance of any mental task, which requires a minimum of mental effort, the subject actually goes through a series of alternating states of distraction (non-work) and attention (work). Kassin (2001) discloses that selective attention is the ability to focus awareness on a single stimulus to the exclusion of other stimuli while divided attention is the behavior to simultaneously engage in two or more activities. As a result, a learner with selective attention can profit from learning more than one with divided attention. Failure to attend to a situation selectively leads to distraction and the information experienced is lost immediately.

Selective attention work hand-in-hand with short and long term memory. Memory consists of three places; registering, storing (based on repetition sometimes) and recalling (based on active repetition). For learning to be successful, all the three stages must be available. Registering information entails transforming or sensory stimuli into the kind of code that memory accepts and that memory accepts and that code is placed in memory. Registering information is also called encoding which is a very important process in literacy development as the child learns to read. Storing means retaining information that has been encoded. Once information is stored, recalling or retrieving it involves recovering the stored information to the working memory. The working memory has been described as an active information processor responsible for storing and processing information for a short time (Baddeley, 1996).

One of the potential factors that might influence children's writing skill is student behaviors such as inattention and hyperactivity. Although correlated, inattention and hyperactivity are distinct constructs (e.g. Goodyear & Hynd). Inattention has been hypothesized to reflect problems in self-regulation of internal cognitive processes while hyperactivity may reflect problems in self-regulation of behavior (Barkley, 1996). Classrooms are complex learning environments where teacher and child characteristics interact and influence children's learning.

Child-related factors, home factors and pedagogical factors influence learning behaviour. Some child-factors can be grouped into biological or psychological factors while those from school and home can be regarded as environmental in nature. The environments in which children are found present different contexts. Developmentally sensitive contexts include many everyday activities involving physical action, play, problem solving, and exploration of materials and events (Martin, 2000). Particularly sensitive are social contexts in which parents and others (e.g., older siblings, preschool teachers, etc.) employ modeling, instructions, questions, conversations, and narratives to mediate critical pre-developmental proficiencies, such as early literacy, numeracy, and language (Tharp & Gallimore, 1989). Early literacy proficiency is highly affected by family income and parent's level of education and occupations (Grouws, 1992; Pond, 1999). For example, better educated parents are more likely to engage in literacy activities at home, which results in higher reading achievement among children in early elementary school (Adams, 1990).

2.3.2 Neurobiological stress reactivity

Feldman (2004:420) states “stress is a part of everyone’s existence, and most people’s lives are crowded with events and circumstances, known as stresses that produce threats to our well-being”. He further argues that stress produces several outcomes. The most immediate is typically biological reaction, as certain hormones, secreted in the adrenal glands, cause rise in the heart rate, blood pressure respiration rate and sweating. Stress may even cause more serious, even life threatening illnesses. According to research, the greater the number of stressful events a person experiences over the course of a year, the more likely he/she is likely to have major illness.

Some children who are raised under deprived conditions show higher levels of behavioural and health problems than their low reactive peers. Such children have been traditionally identified as particularly vulnerable to stressful experiences (Obradovic et al., 2010). In reply to family adversity and poor health, children may manifest neurobiological stress reactivity. A few researchers have challenged this traditional view, arguing that high reactivity, whether measured at the emotional, behavioral, or biological level, is not a unitary, pathogenic response to adversity that invariably leads to maladaptation. Belsky and colleagues (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007), for example, have posited that temperamentally reactive children may show higher susceptibility to environmental influences ‘‘for better and for worse.’’

Ellis and Bjorklund (2012: 594) postulate that young children growing up under more stressful ecological and family conditions tend to develop more insecure attachments, more opportunistic interpersonal styles, and higher levels of aggression, whereas children growing up in more stable and supportive contexts tend to develop more secure attachments and reciprocally rewarding and pro-social interpersonal orientations.

From the perspective of evolutionary biology Ellis et al, (2006) indicate that children growing up in supportive and nurturing families might be expected to develop high levels of biological sensitivity to context in order to take greater advantage of the positive and stimulating features of their environments. As a result of both high sensitivity and protective environments, these children would show high levels of competence and low rates of mental and health problems.

On the other hand, children exposed to high levels of early risk and adversity may also develop high biological sensitivity to context, as a means of sustaining vigilance for environmental threats and hazards. Although such vigilance may be adaptive in the short run, over a longer period of time it could augment children's vulnerability to the deleterious effects of adversity. However, not all pupils, are equally susceptible to environmental influences even when they do not differ in cognitive potential. In developmental psychopathology, the concept of ‘‘differential susceptibility’’ has emerged to acknowledge the accumulating evidence that some children with a specific temperamental or genetic make-up seem to suffer most from negative parenting and at the same time appear to profit most from positive parenting (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Belsky & Pluess, 2009; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2011).

Similarly, Van der Kooy-Hofland et al (2011) have presented the hypothesis that stress reactivity is better conceptualized as a high biological sensitivity to context. From this theoretical perspective, children with heightened biological sensitivity to context are predicted to be more vulnerable to negative and stressful contextual factors, but also to have greater capacity to benefit from positive environmental influences. Temperament is also described as an individual's behavioural style, i.e. to a way how a person repsonds to environmental stimuli. It is independent of one's motives, cognition, skills and capacities, but tells how people reacts. Regarding an interest in a role of temperant in one's behaviour as a rule, a strong association between individual temerament and school achievement is a rather novel finding that has been mostly omitted in learning and educational psychology.

In the context of learning, intense and lasting stress may impact a kid's brain area linked to memory. Research has established that children who had experienced chronic stress compared with their less-strained counterparts have smaller hippocampus (part of a brain related to memory). The brain differences also bore out in cognitive ability, with those children with highly stressful lives performing poorer than other kids on spatial memory tests (http://www.livescience.com/20820-stress-alters-brain-kids.html).

2.3.3 Intelligence

Intelligence directly influences child-learning. However, its expression is highly dependent on the provisions in the child’s home and school environment. For this reason, it is worth highlighting the role of intelligence in academic achievement. Regarding literacy acquisition, intelligence is viewed as a person’s capacity to adapt by learning from experience, solving problems and reasoning clearly, while Myers (1998) notes that according to one of the views, intelligent behaviour varies with situations. He further notes that for Binet and other intelligence testers, intelligence meant children’s ability to adapt successfully to academic work. .

Thornton (2008:340) on the other hand argues that ‘intellectual development through childhood involves an almost continuous process of new discovery, creating revolutions in conceptual understanding in the child. Every normal child shows an astonishing capacity of this kind, as the ordinary basis of developmental growth. However, some children progress towards the milestones of development much more slowly than the average. They learn later than the average, or struggle to keep up with their peers in motor skills in maths, reading or analytical thinking.’

In terms of literacy development, with specific reference to what they called ‘literacy development in inconsistent orthographies’ such as the English Language orthography, Ziegler and Goswami (2005) revealed that more inconsistent orthographies seem to force the reading system into developing multiple grain size mappings and so learning to read such orthographies depends on greater development of extra-cognitive architecture. Therefore, literacy development in a language such as English language is inherently characterized with reading and writing difficulties especially to second language learners. Commeyras and Inyega (2007) also hold the view that the consistency problem reflects the fact that some orthographies have multiple pronunciation and phonological units with multiple spellings. Pupils’ literacy performance in such languages may be associated with notable difficulties. Myers (1998) notes that using evidence from Gardner, the proponent of multiple-intelligence, it is stated that we do not have one intelligence but intelligences, each of course dependent on the other. The linguistically intelligent pupils are more likely to do better than others. Gardner’s notion of multiple intelligence does not seem to be consistent with differential susceptibility as it focuses more on the individual rather than the environmental facilities and aspects.

Kassin (2001) on the other hand notes that linguistic intelligence is a verbal attitude rooted in the auditory and speech centres of the brain and consists of skills involved in speaking, listening, reading and writing. Gardeners’ theory of multiple intelligences has a certain appeal to parents and educators as it is commonly said that parents are their children’s first teachers and the home shapes the initial views of learning. Therefore, parents’ beliefs, expectations and attitudes about their children’s education and achievements have a profound early impact on students’ conceptions of the place of education in their lives.

2.4 Situational factors for academic development

The primary purpose of the present study was to establish the relationship between child characteristics and environments in relation to literacy and numeracy development, the researcher felt that it was necessary to take into account other factors which are relevant in facilitating literacy and numeracy and numeracy development. This consideration would lead to broadly establish how the various factors influence literacy and numeracy skills in order to provide a comprehensive understanding of sources of children‘s shortcomings in early literacy and numeracy skills among Zambian children. The study, therefore, included data on other important factors such as home environment (literacy practice, home possessions), parent’s Social Economic Status, school quality and other related issues. It is expected that these and other factors can play a mediatory role in promoting or hindering early literacy and numeracy skill development.

2.4.1 Child-literacy foundation

The role of early exposure to literacy in fostering literacy development cannot be over emphasized. As literacy development begins very early in a child’s life, Guppy and Hughes (1999) contend that, “research consistently demonstrates that the more children know about language and literacy before they begin formal schooling, the better equipped they are to succeed in reading. Therefore, both the school and home environments play significantly different, but to some extent related roles in initiating and shaping the literacy journey of each learner. Tolchinsky et al (1995) indicate that different perspectives on early literacy influence how literacy is approached in schools and they also influence the way educators make home-school connections in relation to content and process and the roles parents and caregivers can play. It can then be pointed out that the successful development of early emergent literacy cannot, therefore, be detached from the functions of the child’s home and school environments. Children growth described from emergent to conventional literacy is influenced by their understanding of literacy concepts and efforts of parents, caregivers and teachers to promote literacy.

Emphasizing the need for early exposure to literacy knowledge, Ehri et al (2001) state that kindergarten-students benefit from phonemic awareness instruction more than students who receive their first lessons in phonemic awareness in first and second grade. On the other hand, Guppy and Hughes (1999:108) argue that, “a child’s acquisition of phonic knowledge rests on his wider phonological awareness. This awareness is greatly helped by early oral experience of rhymes, alliterations, poems and stories and it holds the key to later success when the learner comes to analyze the print representation of words. The development of this earlier purely oral/auditory knowledge depends on the child’s possessing good listening skills and the adult giving sufficient time dedicated to teaching and demonstration. Therefore, children need to feel that manipulating and playing with sounds is fun, enjoyable and interesting. Stanovich (2000:393) suggests that, “children who begin school with little phonological awareness have trouble acquiring alphabetic coding skill and thus have difficulty recognizing words.”

The care and education of young children are significant issues because of the increased proportions of children living in poverty and their over-representation in special education (Hauser-Cram, Pierson, Walker, & Tivnan, 1991). It is necessary to emphasise the preventive perspective underlying EEI as an effort to counteract the effects of poverty for children (Martin, Ramey, & Ramey, 1990). As mentioned earlier, the conditions of poverty constitute risk factors for children’s early cognitive and social development that are frequently associated with later school failure (Wasik et al., 1990). High-quality, family-oriented, comprehensive EEI may serve as a primary prevention strategy, since it may ensure that these children enter school as healthy and competent learners which will influence their subsequent success in school, thus improving their prospects for a more productive and personally satisfying life (Bryant & Maxwell, 1997; Schweinhart, Barnes, &Weikart, with Barnett & Epstein, 1993).

Preschool children from low socioeconomic status (SES) families are less prepared for formal reading instruction than children from middle and high SES families (Lonigan, Burgess, Anthony, & Barker, 1998; Roseberry- McKibbin, 2008). Insufficient preparation through rich language and literacy experiences in the home often sets young children on a trajectory toward reading failure (Bracken & Fischel, 2008; Hart & Risley, 1995). Due to widespread recognition that early intervention has the greatest potential to compensate for the damaging effects of poverty (Bus & Van Ijzendoorn, 1999; Justice, 2006; Vellutino, Scanlon, Small, & Fanuele, 2006), many children from low-income backgrounds qualify for early childhood education such as Head Start and income-based prekindergarten. The development of reading skills can be enhanced in early childhood education programs if emergent literacy skills are taught.

Consensus has emerged from three decades of literacy research that difficulty with the mental processing of phonological information is a core deficit that accounts for many children's difficulties in learning to read (Adams, 1990; Stanovich, 1988). Phonological processing refers to the use of the sound structure of oral language in processing written and oral information.

Adams (2001) on the other hand observes that to learn to read, all students must know the letters of the alphabet, understand their linguistic significance (phonemic awareness) and learn the logic and conversions governing their use (phonics) and it must be ensured that students grasp of these basics must be a serious goal of any responsible programme of beginning reading instruction. In this vein, Vaughn and Thompson (2004:31) argue that, "the goal of phonic and early word study instruction are to teach children that there are systematic relationships between letters and sounds that written words are composed of letter patterns representing the sounds of spoken words, that recognizing words quickly and accurately is a way of obtaining meaning from them, and that they can blend sounds to read words and segment words into sounds to spell.

Tough (1979) notes that learning to read calls upon a considerable range of skills some of which may assume that the child will have developed through his previous experience. Therefore, the teachers' knowledge of complex skills that must be built up before beginning to read and can also be used to reassure parents that their children are progressing towards reading. Parents and other adults need to be helped to understand the problems children may have if they are introduced to formal reading before they have developed the sub-skills of reading.

Research indicates that children from low-income backgrounds do not receive exposure to literacy-enhancing activities in the home setting (Feitelson & Goldstein, 1986). The relationship between low socioeconomic status and reading achievement is likely mediated by language (Hart & Risley, 1995). Home-background and early experiences of every child play a significant role in starting to read and to manipulate numbers. On the other hand Cunningham and Zibulsky (2014) observed that many children begin to display emergent writing because they are mimicking the adults around them and because they recognize that putting information on paper is both a way to remember it and convey that information to others. Preschool children are capable of interacting with text beyond a literal level, but many only do so when prompted or questioned. Therefore children from homes where parents or caregivers are literate enjoy and benefit from this advantage.

2.4.2 Quality of home environment

Foster et al (2005) have recorded that the quality of the home environment is widely recognized as a strong contributor to young children's emergent literacy and social competence and to their subsequent educational success. Their study examined the relationships between family variables (socioeconomic status (SES), social risk factors, and home learning variables) and children's emergent literacy competence and children's social functioning. It was established that family social risk and home learning experiences mediate the association between SES and children's school readiness in the areas of emergent literacy competence and social functioning.

A child's environment is often cited as one source of influence in the development of intellectual skills. Strong correlations have been reported between various markers for home environment (socioeconomic status, maternal intelligence, characteristics of the home, and parenting practices) and performance on intelligence and other cognitive tests in childhood (e.g., Bradley, 1993; Bradley, Caldwell, & Rock, 1988; Bradley et al., 1989; Molfese, DiLalla, & Lovelace, 1995; Rubin & Balow, 1979; Schaimberg & Lee, 1991; Wallace, Escalona, McCarton-Daum, & Vaughan, 1982; Yeates, MacPhee, Campbell, & Ramey, 1983). It has also been shown that intelligence and cognitive development are differentially influenced by environmental variables. Bradley (1993), Gottfried and Gottfried (1984), and Scarr (1985) described the differential effects of environmental variables according to how directly they influence the child.

Parke and Clarke-Stewart (2011) also note that what working mothers have done as a result of taking employment is to relocate their time and priorities, delegate some household work to others, increase the enrollment of their children in preschool or after school programmes, and re-define their parenting role. The consequence of this can be positive or negative. Rutter (1980) on the other hand indicates that the family consists of a network of relationships implying that the behavior of one individual to another is affected by the relationship of each with others. Dickinson and Tabors (1991) reported that home reading activities and language experiences of preschool children were related to their verbal skills and literacy-related knowledge (e.g., print knowledge, narrative skills). Children's home experiences that expose them to print are related to early word reading skills (Baker, Fernandez-Fein, Scher, & Williams, 1998).

2.4.3 Parents' socioeconomic status

Becher and Epstein (1982) noted that there are economic, educational and cultural barriers to parental involvement. The most predominant explanation is related to socio-economic factors. Hard physical jobs, multiple jobs and long hours of work are some of the factors that limit time, energy and resources of parents to support children at home and attend school meetings.

According to Damarest et al (1993), the family's socio-economic status is based on family income, parental education, parental occupation and the social status in the community. Depending on the circumstances, these qualities can have either positive or negative effects on children's performance in literacy and numeracy. The same factors can also affect a child's performance directly or indirectly.

Damarest et al (ibid) further argue that families with high socioeconomic status often have more success in preparing their young children for school because they typically have access to a wide range of resources to promote and support young children's development. On the contrary, Ramey and Ramey (1994) state that families with low socioeconomic status often lack financial, social and educational support that characterize families with high socio economic status. Poor families especially, have inadequate or limited access to financial, material, social and human resources that promote children's development and school readiness. In addition, poor parents may be illiterate and as such they may lack adequate skills for activities like reading to and with their children. As such, children from families with low socio-economic status are at a greater risk of entering early childhood programmes unlike their peers with medium or high socio-economic status. Pungello et al (2010) also reveal that family income and economic circumstances have a powerful effect on children's development. Like other risk factors, low family income affects children mainly by affecting their home environments and the parenting they receive in ways that hinder optimal development.

Duncan et al (2010) further demonstrates that that poor children have fewer stimulating experiences and learning materials than higher-income children. The effects are apparent in the first years and often last into adulthood. Low-income children, even in the first three years of life, are more likely to have lower cognitive scores and increased behavioral problems.

Feldman (2004) reveals that despite that all learners are entitled to the same opportunity in the classroom, it is clear that certain groups have more educational advantages than others. One of the most telling indicators of this reality is the relationship between educational achievement and socioeconomic status (SES). Middle and high SES-students, on average, earn higher grades on standardized tests and complete more years of schooling than learners from lower SES. There are several explanations why this is so. One thing is that children living in poverty lack many advantages enjoyed by other children. Their nutrition and health may be less adequate, often living in crowded conditions and attending inadequate schools.

Phiri (2012) recorded that

> *Scores of school-going children had abandoned classes in Luwingu preferring to collect caterpillars locally known as 'ifishimu'. About 300 pupils at Mwenda Primary School in Lubansenshi Constituency in Luwingu had abandoned lessons to help their parents collect caterpillars paralyzing school programmes in Senior Chief Shimumbi and Chief Munkonge of Kasama district. Other areas in Northern Province had also reported low pupil turn out because most of them had gone to collect the caterpillars.*

At Mwenda school authorities confirmed to ZANIS that almost 95% of the population at the school had crossed to the neighbouring Lukashya Constituency in Kasama to help parents collect caterpillars. They said that out of 338 pupils, only 38 were attending lessons while others had joined their parents to pick up caterpillars in the bush. They further said for Grade 3 pupils, there were only five pupils attending classes while in Grade 1 and 2 there were no pupils because they were small children who could not be left alone at home in the village.

Some scholars hold different perceptions on how socio economic status impacts children's learning opportunities. While most researchers regard the family socio-economic status to be essential for children's school performance, Kellaghan et al (1993) argue that the family socioeconomic status need not determine a child's achievement at school. They propose that for academic success, it is what parents do in the home, and not children's family background that is significant. Redding (1999) adds that in relation to academic outcomes, parental limitations associated with poor economic circumstances can be overcome by parents who provide stimulating and supportive and language rich experiences for their children. Furthermore, Ceci et al (1999) support that parent-child interactions are the forces that lead to academic performance.

It can also be stated that a lack of social support to the parent has also been identified as a risk factor in studies examining the impact of the family context on children's cognitive and social-emotional and behavioral functioning (Benderasky & Lewis, 1994; Luthar & Zigler, 1991; Sameroff et al., 1997). Social support serves as a buffer against many kinds of stress, and when parents are isolated and without adequate support, parenting stress is increased (Ventura, 1987).

High-quality Early Childhood Care Education plays an important positive role in children's development (Shonkoff & Phillips, 2000), especially in terms of cognitive, social, emotional, and language skills (Currie, 2001; Zaslow et al., 2006). As risks associated with poverty accumulate, they are likely to impact children's developmental outcomes in detrimental ways. (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004).

2.4.4 Poverty

Poverty can be defined as the deprivation, absence or lack of life-supporting resources. Children raised under poverty stricken circumstances face a number of hardships regarding school achievement. Santrock (2004: 555) informs that 'Children who face problems at home and at school present barriers to learning. At home, they might have parents who do not set high standards for them, who are incapable of reading for them, and do not have enough money to pay for educational materials and experiences, such as books and trips to zoos and museums.'

According to results of a landmark study by psychologists Hart and Risley (1995) presented in Feldman (2004) it is argued that the type of language to which children were exposed was associated with their performance on tests of intelligence. The research is also consistent with an increasing body of evidence that family income and poverty have powerful consequences for children's general cognitive development and behaviour.

Apart from poverty affecting children at family level, it also affects them at community level. This may appear to have indirect effects, but for sure some children suffer the consequences in one way or the other. Santrock (2004: ibid) further holds the view that "many of the schools that children from impoverished backgrounds attend have fewer resources than, do schools in higher-income neighborhoods. Schools in low-income areas are more likely to have more students with low achievement scores, lower graduation rates and smaller percentages of students going to college."

Santrock (2005:222) still reveals that ‘Researchers increasingly are interested in manipulating the early environment of children at risk for impoverished intelligence. The emphasis is on prevention rather than remediation. Many low-income parents have difficulty providing an intellectually stimulating environment for their children.’

Thornton (2002:461) observes that “families come in all sorts of shapes and sizes around the world. They may be monogamous (one husband, one wife), or polygamous (one husband, several wives) or polyandrous (one wife, several husbands). Single families are also found in subsistence families where men emigrate to find work, leaving their families at home (a pattern particularly Africa, Asia and Eastern Europe). Usually poverty does not exist in isolation. The interplay between poverty and the other factors such as illness, divorce and parents not having enough quality time for their children worsens children’s welfare and performance at school. Thornton (2002: 459) argues that “In some African cultures, fathers have little or no contact for their children, leaving every aspects of the child’s social welfare to the mothers.”

Research findings have consistently documented that children living in low-income environments enter school with lower levels of skills necessary for becoming good readers, and continue to trail behind peers from middle- and upper-income backgrounds throughout schooling (Arnold & Doctoroff, 2003).

With reference to Zambia, Matafwali (2010) reveals that children who experience substantial difficulties learning to read may constitute a special group within the education system that may unfortunately go unnoticed within the current education provision in Zambia. Longitudinal studies also demonstrate that children who exhibit poor reading skills at the end of first grade fail to reach average reading levels by the end of the fourth grade (Torgesen & Burgess, 1998). Stanovich (1986) has termed this growing gap in development the “Matthew effect”.

It is further argued that children reared in poverty are an important challenge to our understanding of literacy acquisition. Socioeconomic status is one of the strongest predictors of performance differences in children at the beginning of first grade (Raz & Bryant, 1990). Furthermore, children from low-income families are at a distinct disadvantage at the onset of school with regard to language ability (Dickinson & Snow, 1987),

Pungello (2010) indicates that research has identified specific aspects of a child's environment that are associated with later outcomes. Commonly studied risk factors include poverty/income, maternal depression, and low maternal education. They are strong predictors of later outcomes including academic performance, cognitive development, and social and emotional well-being. Risk factors like these can affect children even in the first years of life. Early risk is associated with later behavioral and academic outcomes.

Relating to poverty, is disease. Thornton (ibid: 467) states that "many children today live with chronic illness, some of which are potentially fatal, or with disabilities. Suffering a chronic illness or disability is a wretched thing for a child with potential to all sorts of disruption to normal development, through the disruption of life and other activities. Such children are also unsurprising at greater risk of emotional stress, though very few actually develop symptoms of mental illness."

Several investigators have shown that the compounding of risk conditions in poverty environments has negative influences on children's physical, mental, and social development (e.g., Margolis, Greenberg, & Keyes, 1992; Ricciuti & Scarr, 1990; Sameroff, Seifer, Barocas, Zax, & Greenspan, 1987; Wasik, Ramey, Bryant, & Sparling, 1990). ''The chronic stress and diminished material and psychological resources that often characterize poverty environments combine in synergistic fashion to the detriment of young children’’ (Bradley et al., 1994, p. 347). Specically, the language development of children living in poverty is below what is expected for their chronological age (Montenegro, 1992). Social class differences have been found in children’s oral language skills (Dickinson & Snow, 1987) and in children’s concepts of printed language (Ferreiro & Teberosky, 1982).

2.4.5 Health and nutrition

Health and nutrition usually go together. As such, they have a significant role in promoting learning behavior and outcomes. Young and Durston (1997) hold the view that young children may become disabled if they do not receive enough food or the right kind of food. In severe cases, the brain does not develop properly and the child becomes mentally handicapped. Malnourished children often come from homes that are poor in one way or the other. They lack mental stimulation and they lack the energy and interest to play, so they do not learn and develop as quickly as well-nourished children.

Santrock (2005) states that poor nutrition is a special concern in the lives of young children from low income families. Some researchers argue that malnutrition is directly linked to cognitive deficits because of its negative effects on brain development. An increasing number of researchers argue that the links between child under nutrition, physical growth and cognitive development are very complex. Thornton (2002: 330) adds that “Poor nutrition can stunt growth and good nutrition can enhance it. In some way, intelligence is quite plainly affected by experience and environment. For example, children who have been severely malnourished show a marked decrease in intelligence.”

Costa (2001:229) observes that, “economic realities create cause and effect pattern of thinking and behaving. When people are living in poverty, they devote a great deal of time to survival.” Therefore, raising a child in a poverty stricken home-setting is challenging. Domblewski and Kauffman (1990) note that the demands of parenthood require that a person puts the needs and wants of a child before his or her own. Moreover, families have many different life styles depending partly on the parents' ethnic, religious and social background.

2.4.6 Parental involvement and home learning support

As stated above, the involvement of parents and care givers in the education of children has a very significant role which to a great extent can facilitate children's academic performance. The Intercultural Center for Research in Education (1998) indicates that parental involvement is a key factor increasing emotional support of children's development of literacy, school attendance, teachers' confidence and parents' expertise in helping their children succeed academically. Becher (1984), also states that the evidence on the positive impact of parental involvement on educational outcomes is solid. Research clearly confirms that parental involvement has a positive effect on children's self-esteem and self-confidence to do well in school. Other studies show that teachers can do their work more effectively when they have the collaboration of parents, particularly those whose children are more at risk.

In the same vein, suffice to say children's parents, caregivers and early childhood educators play an important role in ensuring that children successfully progress in their literacy efforts. Best adult-interactions with children through reading aloud and conversations by children's social interactions with each other can have positive effects on school achievement. It is, therefore, imperative that caregivers and teachers in all settings are knowledgeable about emergent literacy and make concerted effort to ensure that all children experience literacy rich environments to support their development into conventional literacy.

Tough (1979:53) on the other hand argues that, "the role played by adults in children's learning is crucial. Unless children have experience of interaction with adults who draw them into particular ways of thinking through talk, they may not fulfill their potential for thinking and using language. For some children, however, the teacher is the only adult they will meet regularly who will have the resources and insight into children's learning to fulfill this role. Myers (1998) states that by observing and imitating models, we learn all kinds of social and academic behavior. There is need to encourage children read, read to them and surround them with books. As models engage in something, children tend to imitate them in both what they are saying or doing does.

Form Lev Vygotsky 's point of view of the socio-cultural theory, the environment is crucial if adults assist children with problems they are confronting. Presley (2002) argues that cognitive development moves forward most certainly and completely if the child is in the world that provides assistance when the child needs it and can benefit from it. In particular, responsive and responsible adults spend a great deal of time talking with their children about things that happened to the child, assisting the child in learning how to be tellers of their own memories.

In the same vein, Kassin (2001) adds that parents who provide an enriched and stimulating home environment by hanging pictures, reading bed time stories, playing games, family travelling and so on foster their children's intellectual growth. Children who are deprived of these experiences thus begin life at a tremendous disadvantage. It is further observed that poverty lowers intelligence and low intelligence leads people into poverty. Foundation year experiences regarding a rich home and school environments are crucial. The National Reading Association and the National Association for the Education of Young Children (1998) also records that the first eight years of a child's life literacy development and as such, at home and at school are crucial for ensuring that children become successful readers. The US Department of Education (1999) also states that researchers now believe that it is better to intervene early and provide the necessary services to prevent students from developing a pattern of failure. The fundamentals for being a reader, cognitive and language skills are learned essential for parents and early caregivers to read daily to babies and toddlers. In the same vein, Alexander and Entwisle (1996) state that even after children begin school, it is important for parents to stay involved in their children's school life.

A study by Burgess et al. (2002) revealed that the home literacy environment played a crucial role in the development of emergent literacy skills, with storybook reading as one of the most significant home learning activities to increase literacy skills. Furthermore, Forget-Dubois, et al. (2009) revealed that the quality of home environment is a well-known predictor of school readiness (SR), although the underlying processes are little known. School readiness (SR) is a multidimensional construct that includes behavioral, emotional, cognitive, and knowledge components that make the child ''ready to learn'' at school entry (Blair, 2002; Chew, 1981).

Studies of the child's home learning environment have repeatedly shown that the language environment in the home and the quality of linguistic interaction and learning experiences with the parent have direct and significant associations with children's cognitive and language development and emergent literacy competence (Dickinson & Tabors, 2001).

Matafwali (2010) further reveals that one facet is literacy opportunity, which refers to the degree to which the home environment provides possibilities for interactions with literacy which may include participation in literacy related activities in the home which can include aspects of exposure (availability of print material) and frequency of reading. The other facet looks at parental guidance during literacy interactions with their children. In the present study however, home literacy environment constituted activities such as the ones proposed by Leseman and de Jong (1998), including activities such as adult support during reading times at home, availability of print material and frequency of reading.

Sénéchal (1997) proposed that parents' literacy level and the availability of reading materials are the material characteristics of the home environment related to a child's literacy development. Leseman and de Jong (1998) distinguished a number of different facets of the preschool home literacy environment that can be related to the two developmental trajectories.

The importance of the home literacy practices is grounded in the fact that the home serves as a setting in which language and literacy is first encountered. It has been found that children's experiences with printed materials could be divided into two distinct categories, namely, informal and formal literacy experiences. Informal literacy experiences are those that expose children to written language incidentally, such as when children listen to an adult read a storybook. During these experiences, the focus of the interaction is the orally rendered test as well as the pictures in the book. These literacy experiences may promote language development because of the richness of the texts in books parents use of questions, and definitions during book reading (Whitehurst et al., 1998), and repeated exposure to specific books (Sénéchal, 1997). In contrast to informal literacy experiences, formal experiences focus directly on the written language. Examples of such experiences include parents teaching their child the names of the letters and teaching their child to print their names (Sénéchal, 2006).

A number of activities have been identified in reference to home literacy environments. Sénéchal et al. (1998) proposed that, home literacy environment would constitute aspects such as; number of books in the home, library visits, and parent's own print exposure. Parents' literacy level and the availability of reading materials are important characteristics of the home environment related to a child’s literacy development.

Over time, parents' involvement evolved to emphasise parents' participation in the policy setting process, parental volunteerism, fundraising, and information exchange (Ratcliff & Hunt, 2009). Most of the research done on parents' involvement directly refers to the parent’s involvement in a child’s schooling activities. They all emphasise the importance of collaboration between school and the family, to understand the unique dynamics in families, in order to improve the children’s development (Johnson, Pugach & Hawkins, 2004).

2.4.7 Motivation and learning-support

Given the various factors that affect can affect literacy and numeracy development and generally school performance, teachers are expected to arouse and sustain children’s motivation for them to learn profitably. This is from the dimension of extrinsic motivation which Kassin (2001) says originates in factors outside the individual. Paradowski (2008) on the other hand contends that while real motivation comes from within each individual, young learners rarely have a clear motivation. They may come to class simply taking it for granted or because they like the teacher. They will all at once be less able to assume responsibility for their learning to use meta-cognitive strategies, focusing, arranging, planning, monitoring and evaluating.

Puolakanaho et al (2008) state that interests and attitudes influence how children look at and perform in a reading task. Children who are interested in the materials presented to them will put forth than will children who have no interest in available reading materials. Lloyd (2007), notes that many problems that students experience are normal responses to stressful events in their lives. These problems are generally temporary. However, the difficulties of students with behavior disorders make it impossible for them to complete fundamental tasks, such as acquiring skills and interacting with teachers or peers.

Like pupils, teachers also need to be motivated. Tough (1979) says if teachers are to use their talk with individual children as a major teaching strategy, it is important that good relationships between the teachers and children are established, that each child enjoys the experience of talking with the teacher, feels comfortable and at easy and is not afraid of giving wrong answers.

2.4.8 Teacher-competence

Developing professional quality teachers is not always a process of steady, but a transformative process in which challenge and the need for change might be termed as prerequisites for professional growth. Many curricula in teacher education are mainly competency based, and teacher educators and researchers in the field of teacher education regard teacher identity as a steady process of acquiring these competencies (Meijer, 2009).

The classroom and what goes on there constitute a very crucial set of factors that have a strong influence on pupils' literacy and numeracy performance. In terms of language learning, to which literacy development is a part, one view by Byrne (1976) indicates that to teach a foreign language is difficult because this is done in the classroom with an artificial setting because language is normally and best learned outside the classroom. The classroom of course is a convenient place for imparting information and for developing many educational skills, but the main concern of language teachers is not to inform students about the language but to develop their ability to use language for a variety of communication purposes. In order to develop the skills needed for this, especially the oral ones of understanding and speaking, teachers have to cope with a number of obstacles such as size of the class, the arrangement of the classroom, the number of hours available for teaching the language and the syllabus itself. Under conditions of large class size, poorly arranged classroom, inadequate time and poorly designed curriculum, it becomes difficult for teachers to provide effective oral language practice and teaching. That is why it is important to have a clear understanding and a firm grasp of the wide range of techniques and procedures through which oral ability can be developed. The role of the teacher, therefore, should be to create the best conditions for learning.

According to the South African National Council of Teachers of Mathematics (2000:17), effective teaching requires knowing and understanding mathematics, learners as learners, and pedagogical strategies." Teachers' mathematics knowledge is essential to effective teaching and learner learning (Ball & Bass, 2001; Shulman, 1987). To teach effectively, teachers must possess the knowledge and skills to (a) effectively structure and present content to learners, (b) understand learners' common conceptions, misconceptions, and difficulties when learning particular content and (c) select specific teaching strategies and techniques that can be used to address learners' learning needs, which derives from Shulman's original notion of pedagogical content knowledge (PCK) (Rowan, Schilling, Ball, & Miller, 2001; Shulman, 1987).

Tough (1979) argues that organization and management of classrooms and teaching areas play an important part in helping teachers achieve the objectives set for the education of young children. Organization and management should serve, support and facilitate the kind of learning the teacher intends to promote. Changes in organization and management should come about in response to changes in objectives and changes in priorities. To do all this, the teachers' competence and experience become key.

The International Reading Association and the National Association for the Education of Young Children (1998) informs that because of various demands of early childhood classrooms, teachers working with young children sometimes find it difficult to match the method of teaching with each child's level of development and individual skills. To be successful in their literacy acquisition for example, children need to grasp basic instructions before they can add new skills. Early screening, assessment and knowledge of children's abilities help ensure that children receive appropriate and individualized instructions. Further, teachers need to be given reading tools and materials to ensure deep understanding of children's literacy development.

Professional development is important in helping teachers understand that appropriate reading and writing skills should be taught to children at appropriate times. Tolchinsky et al. (1995) point out that in a naturalistic view, all children pass through a series of invariant stages that cannot be hurried. Maturation occurs as a result of a biological process of renewal ripening. Nature must be free to take her course and damage could be done if children were hurried, for example into reading.

On the contrary, however, the developmental readiness perspective, suggests that the idea is not that children must be ready to learn how to read. Rather than letting nature take her course, nurturing takes precedence. This approach sees children's readiness for reading able to be influenced by experience. In view of literacy development, Vaughn and Thompson (2004) say that though some pupils will learn to read accurately, quickly and with prosody (good expression) with little direct instruction from teachers, many will require practice and support from peers and teachers to improve their fluency and make reading a more valued activity. It is natural for beginning students to read slowly and laboriously at first. As they rehearse passes, children will get more and more comfortable reading words quickly. Progress monitoring is essential to reading instruction, enabling teachers to keep track of students learning and identify those who need additional help.

Teachers can assess literacy and numeracy skills formally or informally at each grade level. To monitor progress efficiently and be able to offer appropriate learner-support, teachers should assess all students at the beginning of the year in the critical areas for their grade-level. Progress monitoring will help to identify first grade students who are struggling with reading and numeracy skill-acquisition. For example, students who only know a few letters and sounds at the beginning of the year will benefit from intensive instruction in phonemic awareness, the alphabet principle, blending and word building. Students in the second and third grades who are struggling with reading acquisition may need additional practice with fluency building activities, vocabulary instruction that emphasizes structural analysis and decoding multi-syllabi words and additional comprehension skills.

2.4.9 Teaching quality

Teaching quality cannot be detached from the teacher's competence and learners' achievements. Studies on quality in early childhood care and education have demonstrated the relationships among quality indicators such as class size, adult: child ratios, and teacher education and children's cognitive, language, and social development (Burchinal, Roberts, Nabors, & Bryant, 1996; Burchinal et al., 2000; Howes, Phillips & Whitebook, 1992). Teachers who have smaller class sizes and children to adult ratios are more likely to interact positively and sensitively to the children in their classrooms (Phillipsen, Burchinal, Howes, & Cryer, 1997). Similarly, more educated teachers are more likely to have classes rated to be of higher quality (Whitebook, Howes, & Phillips, 1989).

Pianta (2008) on the other hand holds the view that at the broadest level, interactions between teachers and students can be grouped into emotional support, classroom organization and instructional support. In terms of emotional support, children's social and emotional functioning in the classroom is increasingly recognized as an indicator of school readiness (Blair, 2002; Denham and Weissberg, 2004; Raver, 2004 in Pianta, 2008), a potential target for intervention. Children who are motivated and are connected to others in the early years of schooling are much more likely to establish positive trajectories of development in both social and academic domains (Hamre & Pianta, 2001; Ladd, Birch

& Buhs, 1999; Pianta, Steinberg & Rollin, 1995; Silver Measelle, Essex & Armstrong, 2005 in Pianta, 2008). Teachers abilities to support social and emotional functioning in the classroom are, therefore, central to any conceptualization of effective classroom practice.

Furthermore, classroom organization includes aspects related to a broad array of classroom processes related to the organization and management of students' behavior , time and attention in the classroom (Emmer & Stough, 2001 in Pianta, 2008). Classroom function best and provide the most opportunities for learning when students are well-behaved, consistently have things to do and are interested and engaged in learning tasks. To achieve this, children need to develop and apply self-regulatory skills. With self-regulation, "students need to be successful in classroom settings. This term is defined as active constructive process whereby learners set goals for their learning and then attempt to monitor, regulate and control their cognition, motivation and behaviour, guided and constrained by their goals and the contextual features in the environment" Pintrich, 2000:453, in Painta). For students to learn, they must not only have something to do but also must be effectively engaged and interested in the instructional activities provide to them as well (Yair, 2000 in Pianta, 2008). Consistent with constructivist theories that guide much of early childhood practice (Bowman & Scott, 1994; Bruner, 1996; Rogoff, 1990; Vygotsky , 1978 in Pianta, 2008), when teachers provide high-quality learning formats, students are not just passively engaged in learning but are active participants in the learning experience.

2.5 Summary

A number of studies have shown the challenges that are associated with learning and teaching of early literacy and numeracy. This is not a problem in Zambia alone, but in other parts of the world. However, local policies and circumstances determine the nature and extent of the problem. The role of the home and school environments is crucial to the child's success and vulnerability. Child characteristics also play another crucial in determining the nature and quality of literacy and numeracy attainment particularly in the first grade. More research has been conducted in trying to understand literacy and numeracy development in young children. This implies further more still needs to be done in order to give a clearer understanding of this whole matter.

From the literature appears that other aspects of interactions in classroom are influential as well. There are different factors that exist at class level in the various. These include both positive and negative learning atmosphere in class and affect pupils' productivity and concept development. A positive class atmosphere is described as one in which pupils are well supported by the teacher in particular and the school in general. Not every child seems equally susceptible to the same parental, educational, or environmental influences. Children with a fearful temperament appear to suffer most from persistent family conflict or low quality of day care and teaching, but they also benefit most from supportive environments. (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Belsky & Pluess, 2009; Ellis, Boyce. A negative class learning atmosphere implies the absence of teacher's support and lack of facilities such enough and appropriate books, teaching aids, among others.

Deprived home and school environments, therefore, lead to atypical literacy and numeracy development as a result of poor experience and teaching. Thornton (2008) notes that where there are delays in specific skills (such as reading and maths) in a child who is otherwise developing normally, it is tempting to speculate that there may be some specific learning disability reflecting a particular form of problem. Dyslexia is the most commonly identified form of specific learning disability, diagnosed when a child has considerably more difficult in learning to read and write than one would expect from his/her general abilities.

It has been clearly noted that early literacy and numeracy learning is a process dependent on an interplay of factors. These include child characteristics (executive function, intelligence, stress reactivity, among others. These qualities are expressed through an environment which can be at home and at school where learners generally spend their social life. A lot happens at home and school and the child's perceptions, attitudes and motives are created. Arising from the literature presented, the role of environment and quality of attention,, experiences and provisions are extremely importance in the attainment of early literacy and numeracy skills.

CHAPTER THREE
3.0 METHODOLOGY

3.1 Overview

This chapter outlines components of the methodology of the study. These include: research design, target population, study sample, sampling techniques, sampling procedures, data collection instruments, data collection procedures and data analysis. The methodological approach presented below is based on a study conducted from mid-October to the end of November 2013.These aspects show the framework of the study from inception to conclusion.

3.2 Research design

This study was a quasi-experimental research conducted in the real primary school settings. The study sorely utilized quantitative research methods. Yoshikawa, Weisner, Kalil and Way (2008) state that quantitative research methods can be used to understand the prevalence of particular practices and behaviour. Quantitative research seeks to establish relationships and to explain causes of changes in measured social facts. White (2005) states that Quantitative research has a hypothesis in which the relationship between variables such as dependent and independent variables has to be explained at its points of departure. Jere-Folotiya (2014) adds that the strength of the quantitative research lies in terms of amount, frequency and intensity with the view of explaining, describing, and making inferences from obtained results (Babbie,1993'Denzin, & Lincon, 1994). The study was carried out towards the end of children's first grade in order to determine the predictive role of certain child and school characteristics, home factors and school quality. It was necessary that children needed adequate exposure to learning experiences in literacy and numeracy and skills. In this study, child characteristics are those qualities that each child has as an individual they bring into the school. The qualities have some bearing on learning performance. Child characteristics involved the following variables: age, children in other grades in the home, preschool, home literacy, home learning-support, home possessions, RSA (stress) reactivity and five executive function skills (inhibition, shift, emotional control, working memory including planning and organisation.

School characteristics on the other hand related to whether the school was high performing or low performing. This implied that schools differed in the way they were perceived by children's parents and how these schools performed in national examinations at grade 7 and grade 9 levels. Different activities in the classroom also related to school characteristics. For example, teacher competence and attitude towards work, school routines and culture in relation to learner-support and engagement with children's caregivers.

The study was conducted in the third and last term towards the end of the academic year when grade one children had been exposed to reading, writing and numeracy instructions for almost one year. Ten (10) primary schools were selected for the study in the ratio 1:1 meaning five (5) of the schools were low performing while the other five (5) were high performing schools.

3.3 Target population

Grade 1 pupils from selected primary schools from Kasama and Mungwi districts in the Northern Province of Zambia were targeted in this study. Grade 1 teachers and care-givers of the selected children were also involved in the study just to provide information which became part of pupils' data.

3.4 Study Sample

Table1: Age distribution by gender and school quality

School Quality	Low performing N =50		High performing N=50		Total N =100	
Number of schools	5		5		10	
Number of pupils per school	10		10		10	
Gender percentage						
Girls	28%		25%		53%	
Boys	22%		25%		47%	
Age (in months)	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
	109.5	(17.66)	107	(13.27)	108.9	(15.86)

A total of 100 (47 boys and 53 girls) first-grade children were selected and recruited for the study from the 10 primary schools of which five (5) were low performing and the other five (5) high performing schools. Four (4) of 100 children appeared to be much older than the rest (between 132 and 186 months) and were excluded from the sample making the sample size 96 children (45 boys and 51 girls), aged between 77 and 131 months by October/November 2013 when the study was under-taken. This means that the youngest child was 77 months (about 6 years 4 months) and the oldest 131 months (about 10 years 9 months).

All ten teachers from the participating schools indicated that children were placed in four pace groups based on their performance in assessment and class activities. The researcher sought to establish how regular assessment was done and all teachers said they followed guidelines from the Ministry of Education, Science, Vocational Training and Early Education. According to these guidelines, assessment of children in the first grade was to be done once per term. This means that the study target group had been assessed three times that year. It also implies that children were not once and for all permanently allocated to these ability groups because after each assessment, some children may belong to other groups depending on their performance. All ten teachers indicated that participation in literacy classroom activities was the main basis of assessment and ability group-placement for children.

The study sample comprised children enrolled in first grade. Their reading and mathematics skills were assessed towards the end of first grade. Children’s class teachers and their caregivers also participated in the study. There were 100 children (53 girls and 47 boys), 100 caregivers? and 10 class teachers.

Of the 100 children enrolled in the study, 10 of them had their ECG lost during data collection. This means that 10 of the subjects from the sample had missing RSA (stress) reactivity data leaving 90 cases available for RSA (stress) reactivity data analysis.

Each of the participating children was represented by their prominent caregiver. Of these caregivers, 71 (71%) were children’s biological parents while 29 (29%) of them were not biological parents. There were more children coming from home where they stayed with their biological parents and few who were from homes of other relatives.

3.5 Sampling techniques

Two sampling techniques were applied in the selection of schools and subjects in this study. These were: the purposive sampling and stratified random sampling. Gall et. al (2007) informs that “in purposeful sampling, the goal is to select cases that are likely to be ‘information rich’ with respect to the purpose of the study while stratified random sampling involves a sample selected so that certain sub-groups in the population are adequately represented in the sample.” In this study, grade one teachers and the children’s care-givers were purposefully selected because they were in a position to give the required and specific information about each child’s behaviour and home literacy situations. The purposeful sampling technique was also applied in the selection of high and low performing schools from which children and teachers were later drawn.

In the selection of pupil-subjects, the stratified simple random sampling was desirable and applied. Children were selected after reviewing their school-attendance. Children with a regular school attendance were eligible for recruitment in the study. Secondly, eligible children came from the average and above average ability groups to exclude those who were in the below average groups. This was done in order to deal with children who could at least read, write and do some mathematics calculations unlike those who could not perform these academic skills. Children who attended school regularly and were not from the lowest ability groups constituted big groups more than the required number for the study. From the eligible bigger groups, the required ten children were then selected and recruited for the study.

3.6 Sampling procedure

To select the ten (10) pupils from the bigger group of those eligible, as many small pieces of paper as there were eligible children were prepared. Out of these, only ten (10) of them had numbers from 1 to 10 written on them. All the pieces of paper were shuffled in a box. Eligible children were allowed to pick one piece of paper each and those who picked papers bearing the numbers were selected for the study while those who picked papers without numbers were obviously not selected. This procedure accorded every eligible child equal chances to be selected and participate in the study and was followed in all the ten schools.

After identifying and selecting children, with the help of the class teachers and school head-teachers, each prominent child's care-giver was invited for a meeting. These meetings were held at each school before children could be subjected to any research activity. In this case, ten meetings were conducted with selected children's care-givers. During these meetings, the nature of the research, its benefits to individual children and the nation at large were thoroughly explained. All the measures which were to be used in the study were also explained to the caregivers. The use of the VU-AMS device which was meant to measure RSA (stress) reactivity among children was explained. The device involved the use of pre-gelled electrodes stuck on three points of each child's chest region. The device was also connected to the computer for settings and process monitoring. During meetings, the use of the VU-DAMS raised some anxieties in almost every group of care-giver as the device was strange and was perceived to be a medical and not an educational device. Furthermore, at the time of the study, the cultural and social context in Zambia was suspicious of Satanism. Some parents bravely asked about the possible dangers of the ECG measurement. Clarifications and demonstrations were done in which some care-givers volunteered to participate to have a feel before their children could be subjected to such a activity.

3.7 Data collection instruments

Data was captured through a pupils' self-report biographical data sheet, tests to assess reading, writing and mathematics skills, a care-giver's self-report home literacy questionnaire, and the BRIEF. In addition, a physiological electrocardiography (ECG)measure was used to capture children's Respiratory Sinus Arrhythmia (RSA) reactivity to during different positive and negatives of four paired conditions.

The following data collection instruments were used in the study:

(a) Pupil-demographic data sheet

(b) Home-literacy and home learning-support questionnaire

(c) The Basic Skills Assessment Tool (Bemba version-revised)

(d) Mathematics Assessment Battery (adapted)

(e) DLE Mathematics (adapted)

(f) Behaviour Rating Inventory for Executive Function

(g) ECG Measurement Protocol

3.8 Measures and reliability scales

3.8.1 Pupil-demographic data sheet

This instrument included: age, gender, care-givers' socioeconomic status, caregivers' education attainment, mostly spoken language at home, mostly spoken play language and mostly spoken classroom language and home possessions. This information was provided by each individual child through a self-report questionnaire. Part of the demographic data generated from this instrument focused the home possessions (Cronbach's alpha =.82, *n*=11).

3.8.2 Home-literacy and learning-support questionnaire

This home-literacy and learning questionnaire addressed two aspects, namely: the home literacy and the home learning-support. The instrument was administered on children's care-givers at the beginning of the study as a self-report questionnaire (Cronbach's alpha =.74, *n*=10).

3.8.3 The BASAT, Bemba version

The BASAT was the literacy (reading and writing) assessment tool administered at a time when learners had been in school for almost a year. This instrument consisted of seven measures each focusing on a specific literacy skill. The measures included: alphabet knowledge, phonemic awareness including reading and writing. The instrument was administered to children individually and on average took about 25 minutes per child.

Alphabet knowledge was assessed using letter-name and letter-identification including letter-sound and sound-letter association. For alphabet measures, children were presented with an A4 sheet with 26 letters of the English alphabet. These letters were typed in a random order to avoid memorization of the alphabet song but to ensure that the children knew the letters (Cronbach's alpha=.96, *n*=130).

Phonemic awareness was tested through middle and end-sound discrimination of familiar words (Cronbach's alpha = .96, *n*=29). While reading was tested through presenting syllables, words and sentences (Cronbach's alpha = .97, *n*=30), writing on the other hand was assessed from dictated alphabet letters, syllables, words and sentences. In terms of reading comprehension, children were required to associate four pictures each having three word or phrase-options from which a correct one was selected by the child who underlined it (Cronbach's alpha= .98, *n*=31).

3.8.4 Mathematics Assessment Battery

The Mathematics Assessment Battery was the main numeracy assessment tool, adapted from the Netherlands and assessed learners' skills in early numeracy. Like the BASAT, the Mathematic Assessment Battery was administered in the third term of the learners' first year almost at the same time as the BASAT. This tool was also administered individually in a separate room but was done during normal lesson-time. On average this exercise took about 25 minutes per child.

The Mathematics Assessment Battery comprised the following measures: cardinality, counting from 1 to 20, counting principles, number knowledge, number-flash, conservation, nonverbal addition and subtraction, addition and subtraction within a story context, addition and subtraction sums, estimation and number line task (Cronbach's alpha=.77, *n*=50). Presented below are the constituent measures of the Mathematics Assessment Battery.

Cardinality assessed children's knowledge of counting pictorial items displayed on a printed sheet of paper. In this study, different numbers and colour of stars were used were printed on half A4 laminated cards.

Counting principles were assessed in two ways. Firstly, each child was asked to count numbers in the correct order from 1 to 20 none-stop. Then children were asked to count real items (checkers). The items were presented on paper cards in a one-to-one correspondence to guide the assessor so that a clear protocol was followed for all children. Different numbers of items were arranged in different formations.

Number knowledge tested children's knowledge of number position and size between two given numbers. Number conservation on the other hand sought to examine if children would understand the same number concept displayed using grouped and split displays. Physical counters were used to assess this concept.

Addition and subtraction with checkers tested children's knowledge of how to add and subtract items using concrete objects such as stone and counters. Addition with stories on the other hand tested children's knowledge on how to add and subtract using simulation stories of real life using locally available items while abstract addition and subtraction tested learners' knowledge of mental addition and subtraction.

Estimation tested children's knowledge of approximating quantities of dots presented on printed and laminated A4 paper. The test did not demand that a child to say the exact number of dots on each card, but to give an estimation of 25% more or less the exact number of dots.

3.8.5 DLE Mathematics

The DLE Mathematics was another numeracy assessment tool. The instrument was adapted from the Netherlands and was meant to assess abstract ability children's in addition and subtraction mathematics. The whole test had 80 sums clustered in four groups. The sums were arranged in four clusters of four columns and five roles each. Each role bore sums of the same mathematical operation. In clusters-roles 1,3 and 5 the addition (+) operation sign was used while in roles 2 and 4 the subtraction (-) operation was used. This was the pattern for the first three clusters. For the fourth cluster, all the four operation signs of plus (+)**,** minus (-)**,** multiply (x) and divide by (÷) were used. In terms of difficulty, the first clusters had simpler sums while the last clusters had the more difficult sums meaning that the clusters were arranged from simple to complex. Like the other tests, the DLE Mathematics was administered individually to children.

In terms of timing, the DLE Mathematics was unique in that each child was expected to attempt as many questions as possible in two minutes only. None of the children, however, attempted items in the second, third and fourth clusters (Cronbach's alpha =.87, *n*=20).

3.8.6 BRIEF descriptives

Table 2: Cronbach'a alpha reliability scales

Skill-category	Number of items	Cronbach alpha
Inhibition	16	.83
Shift	10	.85
Emotional control	10	.87
Working memory	17	.88
Plan. and organisation	10	.81
BRIEF TOTAL	**63**	**.95**

The Behaviour Rating Inventory of Executive Functions (BRIEF) specifically measured each child's executive behaviour which included: inhibition, shift, emotional control, working memory including planning and organisation. These skills are important in regulating learning and performance of learners in academic skills such as reading, writing and mathematics. Children's teachers filled in the BRIEF questionnaire for every child.

The BRIEF was used to provide information about the everyday behaviour associated with specific domains of the executive functions. In this tool, different scales measured the extent to which the respondent (teacher) reported problems with different types of behaviour related to each of the domains. In total, there were 63 items of the BRIEF with Cronbach's alphas as tabulated in Table 2 above.

The Inhibition scale assessed children's inhibitory control and impulsivity. This is the child's ability to resist impulses and the ability to stop one's own behavior at the appropriate time. In classroom and assessment settings, children with inhibitory control difficulties often require a higher degree of external structure to limit their impulsive responding. They may start an activity or task before listening to instructions, before developing a plan, or before grasping the organization or gist of the situation (Cronbach's alpha=.83, *n*=16).

The shift scale assessed the child's ability to move freely from one situation, activity or aspect of a problem to another as the circumstances demand. Key aspects of shifting include the ability to make transitions, tolerate change, problem-solve flexibly, switch or alternate attention and change focus from one mindset or topic to another (Cronbach's alpha =.85, *n*=10).

The emotional control scale measured emotional expression and assessed a child's ability to modulate or control his or her emotional responses (Cronbach's alpha =.87, *n*=10).

The working memory scale measured the capacity to hold information in mind for the purpose of completing a task, encoding information, or generating goals, plans and sequential steps to achieving goals. Working memory is essential to carry out multistep activities, complete mental manipulations such as mental arithmetic and follow complex instructions. Appropriate working memory is necessary to sustain performance and attention among children (Cronbach's alpha =. 88, *n*=17).

The planning and organization scale measured the child's ability to manage current and future-oriented task demands. The scale is comprised of two components: plan and organize. The planning component captures the ability to anticipate future events, to set goals and to develop appropriate sequential steps ahead of time in order to carry out a task. The organization component on the other hand refers to the ability to bring order to information and to appreciate main ideas or key concepts when learning or communicating information (Cronbach's alpha = .81, *n*=10).

3.8.7 Electrocardiography(ECG) measurement protocol

Prior to conducting this measure during data collection, the underwent three month course at the Leiden University, Department of Child and Family Studies. The training involving the use of the device when collecting data, how to prepare the child psychological in order to have the best out of such a measure. The raining was practical in nature as it involved participating in similar measures taking place at the same University. Observations were part of the training followed by peer- trails whose results were discussed and analysed accordingly.

The VU-DAMS device was used to measure electrocardiography (ECG) which can also be described as Respiratory Sinus Arrhythmia (RSA) reactivity. This is a measure of parasympathetic stress response and refers to high-frequency heart rate variation controlled by efferent fibers of the vagus nerve during the respiratory cycle. Vagal regulation, in the form of increases and decreases in RSA has been regarded as an index of children's capacity to regulate responses to positive and negative environmental demands (Beauchaine, 2001; Beauchaine, Gatzke-Kopp, & Mead, 2007; Porges, 2001, 2003, 2007). High levels of basal RSA have been associated with social competence, empathy, and emotion regulation (Beauchaine, 2001; Eisenberg et al., 1995; Fabes, Eisenberg, &Eisenbud, 1993; Fox & Field, 1989). Low basal RSA, on the other hand, may indicate emotional liability and dysregulation and has been linked to behavior problems in at-risk or clinical samples.

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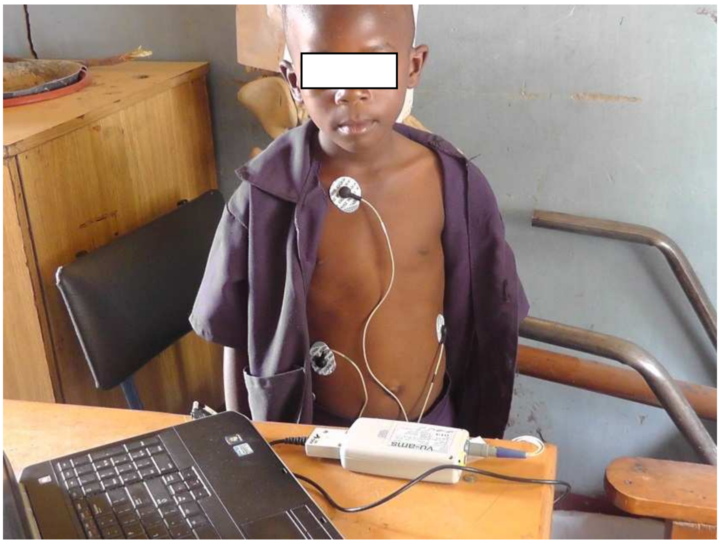
To measure stress in the present study, four paired tasks (social, cognitive, sensory and emotional) were presented to each child. Each of the four tasks was paired comprising positive and negative situations which were presented in sequence with pauses (breaks) lasting one minute in between. The presentation of these tasks was done after each child had been connected to three electrodes of the VU-AMS device. During the paired tasks and the pauses in between each child's stress reactivity was registered.

Figure 1: How the VU-DAMS device was connected prior to ECG measurement



Care-givers who positively consented in writing that their children could participate in the study were then made to complete a questionnaire regarding home-literacy and home-learning support. This child-recruitment procedure and care-givers' preparation procedure was followed in all the ten schools.

3.9 Data collection procedure

To collect data from each of the ten schools, about three days on average were spent and the whole period for data collection took about one and half months (mid-October to end of November). Prior to data collection, children's parents were invited for meetings held at school. During these meetings necessary formalities were conducted to receive informed consent from parents before proceeding to collect data.

Secondly, data from grade one teachers was collected through the BRIEF, a questionnaire which was given to each grade one teacher whose children were selected and recruited in the study. The completed questionnaires were collected back from each teacher after about three days. During the same period, other instruments were administered when children were attending their normal learning.

At a given time, one selected child was withdrawn from class to be assessed. Upon completion, each child returned to class to join other children who were in class. When children knocked off from school on a particular day, data collection involving children was halted and continued the next day.

Before and during data collection, appropriate and uniform research procedures were followed. These included getting written informed consent from children's parents or caregivers and grade one teachers. Children gave verbal consent prior their parents' and teachers' consent. This procedure was observed in order to prepare and respect all participants' rights and integrity as they got involved in the study. It also prepared these participants psychologically when capturing data so that they behave

At each of the selected schools, the recruited children participated in the study in two ways. Before subjecting pupil-subjects to any form of data collection, official permission and consent were sought. This was done by seeking permission from the provincial, district and school administrators and then children's parents and teachers were involved. At each of the schools, with the help of grade one teachers, ten children were selected for the study. School head-teachers facilitated the invitation of children's caregivers for meetings whose purpose was to explain the nature and purpose of the research in which their children had been enrolled. Of critical interest was the stress measurement on children using the VU-AMS device that used electrodes placed on the three points of the child's chest-region. After adequately explaining to children's caregivers at each school, consents in writing by filling-in a form were done. This was followed by completing a home-literacy and home learning-support questionnaire. Care-givers who were able to read and write completed the questionnaire themselves while those who were not able to read and write were assisted by the researcher and research-assistants to respond to the questionnaire.

During research sessions at each school, children were subjected to a self-report questionnaire to provide demographic information about certain personal and home characteristics. Then each child was tested individually in reading, writing and numeracy skills through the BASAT, the Mathematics Assessment Battery and DLE Mathematics. The three instruments together with the Electrocardiography (ECG) measurement were administered in turns in a separate room where children were called one at a time. All assessments on children were conducted when all children were in school attending lesson so as to make the research as part of the normal time children spent in school. On average 25 minutes were spent administering the BASAT and the Mathematics Assessment Battery. A maximum of four days were spent at each school to meet parents and collect data from all the ten children.

3.10 Data analysis

First and foremost, variable totals were created from raw scores. Then, the data were inspected by descriptive statistics which included: means, standard deviations, minimum, maximum, Cronbach's alpha reliability scale, skewness and kurtosis. This procedure was important in order to find out whether the variables had extreme values and outliers or whether the variables were normally distributed. "Screening continuous variables for normality is an important early step in almost every multivariate analysis, particularly when inference is the goal" (Tabachnick and Fidell 2013:79).

The following variables were subjected to the data inspection procedure: home possessions, child behaviour (BASAT), alphabet-naming, alphabet-identification, alphabet-writing, writing two-letter syllables, writing three-letter syllables, writing three or more letter words, discriminating, discriminating middle-sounds, making or writing syllables, reading one-syllable words, reading two-syllable, reading three-syllable words, reading short-sentences, relating letters to sounds, relating sounds to letters, digit span, reading comprehension, inhibition, shift, emotional control, planning and organisation, counting principles, addition with checkers, subtraction with checkers, addition with stories, subtraction with stories, abstract-addition, abstract-subtraction, estimation, number flash naming, writing own name, reading own name and DLE Mathematics correct sums. Four variables namely: emotional control, working memory, addition with stories and number flash were found to be skewed due to outliers. Therefore, these variables were winsorised. To winsorise simply means to normalize the distribution of data by closing up gaps between too low or too high scores so as to do away with extreme scores of outliers.

To assess children's stress reactivity, an Electrocardiography (ECG) protocol was followed. The protocol comprised eight (8) paired tasks categorized as: social, cognitive, sensory and emotional. Each task was divided into two, that is the positive and negative (challenge) tasks. When each child was invited for the ECG measurement, it was a procedural requirement that the child was informed about the nature of the measurement by explaining and showing the device to be used and generally how it would be used. Permission was sought from each child after which the actual measurement proceeded.

Children's stress reactivity was assessed using changes in RSA during the stress reactivity protocol. After the child was familiarized with the equipment, three pre-gelled ECG electrodes were placed on the right clavicle and lower left rib as already explained. A 4 mA AC current at 100 kHz was passed through the electrodes.

RSA was monitored continuously during the protocol. Data were acquired using the Biopac MP150 (Biopac Systems, Santa Barbara, CA) interfaced to a PC-based computer. Analog data were continuously monitored on the computer for signal and noise, and digitized data were stored for offline analysis in a memory card placed in the VU-AMS device. RSA was derived in accordance with recommendations of the Society for Psychophysiological Research committee on heart rate variability (Berntson et al., 1997). The sampling frequency was 1 kHz. Prior to analyses, each waveform was verified with +30 and -30 wave range was used. Inter-heart Beat Intervals (IBIs) were visually checked, and artifacts were identified using a software programme (Berntson, Quigley, Jang, & Boysen, 1990). RSA was estimated as the natural logarithm of the variance of heart period within the high frequency bandpass associated with respiration at this age (i.e., 0.15– 0.80 Hz; Bar-Haim, Marshall, & Fox, 2010).

A calming story lasting two minutes was told to each child followed by a pause for one minute. For each paired activity, the positive task was the first to be administered lasting about 2 minutes followed by a one minute pause, then the negative task lasting about 2 minutes as well. All the other paired activities were conducted following the same procedure guided by a written protocol. Before concluding the measurement protocol, another calming story lasting two minutes was told to the child. After this story, the child was thanked and reassured that the whole ECG measurement activity conducted was safe for him of her. The child left the assessment room and was escorted back to classroom by a research assistant who came with another to under-go the same procedure.

After successfully collecting data, a step-by-step analysis procedure was followed. To start with, the computer software was up-graded from VU-DAMS 2.2 (used during data collection) to VU-AMS 3.2 (used during data analysis). This upgrading was necessary in order to be able to measure RSA which was one of the target measures needed in this study. Prior to that, label markers were added to the data files manually by the researcher on the 90 cases on whom ECG was measured successfully out of the 100 subjects. This was done in order to show in the data the four paired tasks for which stress was measured. The paired four tasks were lined up as follows: social control with social challenge, cognitive control with cognitive, sensory control with sensory challenge and emotional control with emotional challenge. The control components were positive activities while the challenge were negative activities. Later, R-peaks were detected before Inter-heart Beat Intervals (IBIs) which were exported to ASCH files for each subject. Later, using Matlab, a computer software, the RSA beats were transformed and written to excel. To do a Matlab script suitable for young learners, frequencies were adjusted from the range of 0.15Hz - 0.80Hz to 0.24Hz -1.0Hz (Bar-ham, 2010).

High RSA (stress) reactivity is indexed by decreases in RSA from the basal level and is associated with more attention and increased engagement during challenging situations. On the other hand, low RSA stress reactivity is indexed by increases in RSA from the basal level and is associated with less attention and decreased engagement during challenging situations. RSA (stress) reactivity can be simplified and as follows: *High reactivity is indexed as decreased RSA scores leading to more attention in learning whereas Low reactivity is indexed as increased RSA scores leading to less attention in learning.*

To analyse the data, a variety of statistical techniques were utilized to explore relationships and determine prediction of outcome variables from a number of independent variables. The main techniques included: descriptives, dimension reduction, bivariate correlations, linear regression and discriminant analysis. Therefore, a strength in the methodology of the present study is that the researcher applied multivariate statistical techniques (e.g. discriminant function analyses and linear regression analyses) to explore the relation between independent and dependent measures. The next chapter presents the findings of the study.

3. 11 Ethical concern

Ethical clearance was obtained and two stages, firstly from the University of Zambia Research and Ethics Committee (UNZAREC) and secondly from the Ministry of Health Headquarters. A full research proposals of this study was presented to UNZAREC for review. Upon review, UNZAREC recommended for a further review at the Ministry of Health based on the nature of the device (VU-DAMS, a stress measuring instrument from the Netherlands) that was used in the study. After their review by Ministry of Health Headquarters, the study was cleared as well. In addition to ethical clearance, written informed consent was always received from children's parents before children were involved in any research activity. Prior to written consent, the researcher always explained to the care-givers through meetings the nature of the study, its benefits and safety. Participants were given supplementary written information which highlighted their rights indicating that they were free to withdraw from the study anytime they felt so. However, no parent ever withdrew their child from the study midway except for three parents who during initial meetings indicated that their children be excluded from the study and those children were not enrolled for the study.

3.12 Summary

The research methodology outlines how the cross-sectional approach in the current study was conducted at a time when children had been in their first grade for almost one year. The researcher opted to apply this approach in order to examine to what extent child-characteristics, home and school factors predicted literacy outcomes at the end of grade one. The study sample included children from low and high performing schools where language of wide communication was similar, in this case Bemba.

A wide range of standardised measures were, used to assess literacy and numeracy abilities as well as background factors. These measures have extensively been utilized in early literacy studies both in national and international studies (Matafwali, 2005; Dickinson et al., 2003; Storch & Whitehurst, 2002; Denkla & Rudel, 1976; Dunn & Dunn, 1997).

CHAPTER FOUR
4.0 PRESENTATION OF FINDINGS

4.0 Overview

This chapter presents findings of this study whose primary purpose was to examine differential effects of child characteristics on early literacy and numeracy skill attainment at selected low and high performing primary schools in Northern Province of Zambia. The study also aimed at exploring the predictive role of various child characteristics in school context.

To assess literacy (reading and writing) skills, the BASAT was used while the Mathematics Assessment Battery and the DLE Mathematics, both adapted from the Netherlands were used to assess numeracy skills. Background variables on the other hand included: the demographic data, home-literacy and home learning-support, executive functions, and the RSA (stress) reactivity.

This chapter presents the findings on this cross sectional study. These findings are presented under the following broad categories: dimension reduction for literacy and numeracy skills, descriptives (means and standard deviations), bivariate correlations of the main variables, discriminant analyses and regression analyses.

The first section of the presentation of the results deals with dimension reduction. This was done in order to reduce on the bulkiness of the variables in order to create clusters of variables called components. After performing the dimension reduction analysis, there were five academic variables in total, three of which based on literacy (alphabet knowledge, phonemic awareness and reading and writing) and two on mathematics (number facts and number sense). The five variable clusters were later used in later analyses.

Having reduced the wide variable arrays into components, means, standard deviations, t-statistics and their levels of significance were computed for pupils from high and low performing schools. Two analyses were later performed based on grouping and linear prediction. First the discriminant function analysis was carried out with school quality as dependent measure to assess the differences in the five academic variables as well as four selected background variables. Furthermore, linear regression analyses were carried out to predict academic performance from a number of background variables. The same procedure was also carried out to predict RSA (stress) reactivity from a number of selected variables. The actual and detailed analyses are presented below.

The relationship among child-characteristics, home environment and academic performance among young children in two school-settings was the main focus of the study. The primary purpose was to examine the predictive role of different background characteristics as precursors of early literacy and numeracy skill attainment. The study further aimed at establishing the predictive role of one set of academic skills to the other.

4.1 Dimension reduction of factor analysis

Factor analysis was applied to literacy and numeracy skills. The aim of this procedure was to reduce the number of variables. The dimension reduction of principal factors by extraction with varimax rotation was used as an initial run in order to estimate the likely number of factors with a threshold of eigenvalues above 1.0. This procedure was separately run for literacy and mathematics measures. Consequently, the complexity of the data was then reduced by regrouping variables into fewer components. In each case, scree plots guided the selection of components hierarchically arranged based on the eigenvalues. These plots helped to decide how many factors to extract as indicated by the eigenvalues. From the component matrices, new variable categories were selected according to the loadings which were used in the main analyses of data.

4.1.1 Literacy (reading and writing) components

Table 3: Dimension reduction on literacy (reading and writing) variables

	Component		
Variables	1	2	3
Alphabet naming	---	.643	---
Alphabet identification	---	.695	---
Alphabet writing	---	.627	---
Writing two-letter syllables	.904	---	---
Writing three-letter syllables	.763	---	---
Writing words with 3 or more syllables	.883	---	---
Reading short sentences	.892	---	---
Relating letters to sounds	.799	---	---
Relating sounds to letters	.749	---	---
Discriminating end sounds	---	---	.706
Discriminating middle sounds	---	----	.742
Reading one-syllable words	.796	---	---
Reading two-syllable words	.731	---	---
Reading three-syllable words	.866	---	---
Reading comprehension	.642	---	---

Extraction Method: Principal Component Analysis.

a. 3 componentsextracted.

Table 3 above shows the variable loadings to form variable components. There were high loadings on component 1 (reading and writing) of variables including: reading and writing syllables, reading words and sentences, relating letters to sounds, relating sounds to letters and reading comprehension. On

Component 2 (alphabet knowledge) loaded alphabet-naming, alphabet-identification and alphabet writing while component 3 (phonemic awareness) included discriminating middle and end sounds in words. Components with less than 1.0 eigenvalue threshold were not included. Therefore, only the three components were included in other analyses in the study.

In terms of explained variance, the three components (reading and writing, alphabet knowledge and phonemic awareness) accounted for 53%, 12% and 8% of the variance, respectively. These components were suitable for use in further analyses of literacy academic skills.

4.1.2 Mathematics components

Table 4: Dimension reduction of mathematics variables

Variables	Component 1	Component 2
Addition with checkers, stories and abstract	---	.710
Subtraction with checkers, stories and abstract	---	.729
Number flash naming	.771	---
Estimations	---	.753
DLE Math addition and subtraction correct scores	.755	---

Extraction Method: Principal Component Analysis.

a.2 components extracted.

Table 4 shows the variable loadings on two mathematics components. Component 1 had high loadings of variables assessing number-facts while component 2 had high loadings of variables that related to number-sense. The constituent variables for component 2 included addition with checkers, stories and abstract, subtraction with checkers, stories and abstract, and estimations. Component 1 on the other hand was determined by number flash naming and DLE Mathematics. The DLE Mathematics was based on abstract addition and subtraction. The other variables with an eigenvalue threshold of less than 1.0 were excluded. In terms of explained variance, the two components (mathematics number-facts and mathematics number-sense) accounted for 47% and 20% of the variance, respectively. The two components representing mathematics variables were then available and useful in further analyses.

4.2 Relationships among background and dependent variables

Table 5: Bivariate correlations among background and outcome variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age in months	1																	
2. Relationship to child	-,083	1																
3. Children in other grades	-,017	,216*	1															
4. Pre-school	-,210*	,211*	,030	1														
5. Home possessions	-,273*	,203*	,071	,522**	1													
6. Home-literacy	-,032	,504**	,610**	,196	,205*	1												
7. Home learning-support	,042	,414**	,277**	,019	-,008	,623**	1											
8. RSA (stress) reactivity	-,023	,070	-,109	,206	,014	,055	,007	1										
9. Inhibition	-,134	,190	,228*	,171	,148	,190	,029	,061	1									
10. Shift	-,183	,170	,255*	,142	-,038	,239*	,086	-,036	,664**	1								
11. Emotional control	-,194	,198*	,199*	,177	,228*	,204*	-,043	,055	,791**	,714**	1							
12. Working memory	-,209*	,150	,181	,182	,149	,164	-,038	,013	,754**	,736**	,884**	1						
13. Planning and organ.	-,138	,124	,114	,196	,114	,181	-,105	-,015	,559**	,661**	,735**	,756**	1					
14. Quality of school	-,061	-,110	-,228*	,040	,000	-,146	-,144	-,024	,042	,115	,287**	,319**	,253*	1				
15. Reading and writing	-,057	-,106	-,173	-,105	-,187	-,116	,001	-,182	-,118	-,055	-,135	-,118	-,099	,219*	1			
16. Alphabet knowledge	-,022	-,077	-,043	,197	,268**	-,076	-,054	,052	,060	-,118	-,101	-,105	-,196	-,076	,000	1		
17. Phonemic awareness	-,111	-,070	,012	,005	,123	-,113	-,162	,107	,078	,034	,111	,095	,167	,062	,000	,000	1	
18. Maths-number facts	,106	-,202*	,111	,032	-,085	-,064	-,037	-,157	,114	,042	,074	,046	,029	-,116	,183	,156	,214*	1
19. Maths-number sense	,202*	-,094	-,012	-,288**	-,152	-,094	,085	,178	-,110	-,195	-,218	-,270**	-,345**	-,275**	-,198*	,032	,030	,000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5 above displays correlations among all the background and outcome variables used in the study. From the display, age showed negative correlations with preschool, home possessions and working memory (*r*= -.20, -.27 and -.21, respectively). These results imply that older children did not attend preschool and came from homes with fewer home possessions (low SES) whereas younger children attended preschool and came from homes with more possessions.

Regarding working memory, however, results show that older children had better working memory compared to younger ones (*r*= -.21). Mathematics number-sense on the other had a positive correlation with age (*r*= .20), an indication that older children performed better in Mathematics number-sense than younger ones. With regards to care-givers' relationships with children, the variable was divided into two types of relationships namely: biological and other care-givers. This variable recorded significant positive correlations with children in other grades (*r* = .22), preschool (*r* = .21), home literacy (*r* = .50), home learning support (*r* = .41) and emotional control (*r* = .20) respectively. This implies that children who lived with biological parents had more siblings, from whom they enjoyed home literacy and learning support and were rated poor at working memory.

Mathematics number-sense had a significant but negative correlation (*r* = -.20) meaning children with biological care-givers performed poorly on this variable. This means that children whose caregivers were not their biological parents, recorded poor performance on mathematics number-sense variable.

When children had brothers or sisters in higher grades this variable had a significant positive correlation with home literacy (*r* = .61) and home learning support (*r* = .28), respectively. This moderate but significant correlation shown above suggested that the presence of other siblings in the home accorded children's opportunities to share academic work as care-givers could not be the only ones to offer this type of support to children in the home. On the other hand children in other grades was positively correlated with inhibition, shift and emotional control *(r* = .23, .26 and .20, respectively). These results show that children with siblings in higher grades were rated low on these three executive functions skills.

Children with siblings in other grades went to low performing schools (*r* = .23). However, preschool came out as a significant and positive correlate of home-possessions (*r* = .52), suggesting that children who came from families with more home possessions (high SES) had access to preschool. Though not significantly, children with brothers or sisters in higher grades experienced more social interactions, thereby having more home literacy opportunities and had a high index on RSA (stress) reactivity (*r* = .21) which means that these children were not easily stressed during challenging situations. Results also show that children with a preschool background performed poorly in mathematics number sense (*r* =-.29). This result indicates that going to preschool did not give any performance advantage in mathematics number sense. This might mean that in Zambia, most preschools do not operate to serve as preparatory institutions before children enter formal education, but serve as day care centres where parents take their children in order to freely engage in paid work or business.

Home possessions correlated significantly with home literacy (*r* = .21), emotional control (*r* = .23) and alphabet knowledge (*r* = .27). For home literacy and alphabet knowledge, the correlations meant that children who came from homes with more home possessions (high SES) had access to home literacy as a result they did well in alphabet knowledge, but were rated poorly in emotional control.

Home literacy correlated significantly and positively with home learning support (*r* = .62), shift (*r* = .24) and emotional control (*r* = .20). These results suggest that children who had literacy opportunities at home also enjoyed some learning-support either from caregivers or siblings in the home. However, these children were rated poorly by the teachers on shift and emotional control.

Home learning support and RSA (stress) reactivity had no significant correlations. However, the two variables recorded negative correlations with planning and organization, school quality and phonemic awareness implying that children who had home learning-support were rated low on planning and organization. These children went to high performing schools and were not easily stressed during challenging situations.

Regarding RSA (stress) reactivity, there were two strong negative correlations with reading and writing and mathematics number-facts and a positive one with mathematics number-facts. These bidirectional results suggest that children who were easily stressed during challenging situations were better at reading and writing and mathematics number facts but poor at mathematics numbers sense.

The five executive functions showed positive and significant correlations amongst themselves but quite high negative correlations with reading and writing and mathematics number sense. These results indicate that children rated high on executive functions scored high on those two academic skills. Furthermore, working memory, reading and writing (r = -.12) and mathematics number sense (r = -.27) revealed negative correlations. This means that children who were poor at working memory were also poor at reading and writing and mathematics number sense.

Emotional control, working memory, planning and organization recorded significant positive correlations with school quality (r = .28, r = .32 and r = .25, respectively). These results indicate that children who went to high performing schools were rated poorly on emotional control and working memory and performed poorly in mathematics number-sense.

Furthermore, school quality had a significant positive correlation with reading and writing (r = .22) and a negative one with mathematics number facts and number sense. This means that children who went to high performing schools did better in reading and writing but were poor at mathematics number facts and number sense. Reading and writing was correlated negatively with mathematics number sense (r = -.20), meaning children who performed well on reading and writing had difficulties with mathematics number sense. On the other hand, phonemic awareness and mathematics number-facts were positively correlated (r = .21) implying that children who scored high on phonemic awareness also did well in mathematics number-facts.

In sum, correlations show that children's biological caregivers were associated with more home possessions, high literacy opportunities in the home and lots of learning support. Regarding the presence of other children in the home, children with more siblings in the home had better access to home literacy opportunities as well as enjoyed more home literacy support than their counterparts who came from homes without other children in the home. High SES as represented by more home possessions correlated with good performance in alphabet knowledge, but not in mathematics number sense. Results clearly suggest that both preschool and home possessions contributed to good attainment in alphabet knowledge. For mathematics number sense, both preschool and home possessions tend to indicate poor performance. Furthermore even children who had home learning support did not seem to do well in academic skills.

4.3 Comparison between Low and High performing schools

Table 6: Descriptives: Means, Standard Deviations, t-statistics and p-values

Variable	*Sch. Quality*	*M*	*SD*	*t*	*p-value*
Age in months	Low	109.5	(17.66)	.00	1.000
	High	107	(13.27)		
Relationship to child	Low	.78	(.42)	1.67	.110
	High	.62	(.49)		
Children in other grades	Low	.49	(.51)	2.46	.016
	High	.24	(.44)		
Preschool	Low	.42	(.07)	.00	1.000
	High	.46	(.07)		
Home possessions	Low	6.33	(2.92)	.57	.570
	High	5.98	(3.00)		
Home-literacy	Low	6.11	(2.65)	1.85	.067
	High	5.02	(2.92)		
Home learning-support	Low	19.18	(4.78)	1.46	.067
	High	17.67	(5.02)		
RSA (stress) reactivity	Low	.05	(2.16)	.23	.147
	High	-.05	(2.27)		
Inhibition	Low	7.33	(5.08)	.63	.882
	High	6.73	(3.92)		
Shift	Low	5.29	(4.83)	-.47	.532
	High	5.69	(3.12)		
Emotional control	Low	3.84	(2.76)	-2.04	.042
	High	5.07	(2.92)		
Working memory	Low	6.44	(5.93)	-2.45	.044
	High	9.22	(4.77)		
Plan. and organisation	Low	3.40	(3.27)	-2.21	.016
	High	4.87	(3.03)		
Reading and writing	Low	-.27	(.83)	-2.64	.030
	High	.27	(1.12)		
Alphabet knowledge	Low	.03	(.79)	.52	.600
	High	-.08	(1.18)		
Phonemic awareness	Low	-.11	(1.07)	-.49	.604
	High	.09	(.97)		
Mathematics-number-facts	Low	.07	(.97)	.60	.623
	High	-.05	(1.04)		
Mathematics-number-sense	Low	.19	(.97)	2.48	.053
	High	-.29	(.88)		

p-value significant at p<.05

Table 6 above presents means, standard deviations, t-statistics and p-values of background and dependent variables by school quality arising from dimension reduction of factor analysis.

From the whole array of variables, significance differences were noticeable on the following variables.

Children in other grades in the home (t=2.46) suggests that most children who went to low performing schools came from homes where there were more children in other grades. This also means that most children who went to low performing schools came from relatively larger families.

*Working memory (t=-2.45) r*esults indicate that children who went to high performing schools were rated by their teachers to have better working memory while those who went to low performing schools were rated to have poorer working memory. A similar pattern was found for planning and organization *(t=-2.21)* indicating that children who went to high performing schools were better at planning and organization compared to those who went to low performing schools. This is also the case with emotional control (*t*=-2.04) suggesting that children who went to high performing schools were better on this variable.

Alphabet knowledge(t=.52) reveals that children who went to low performing schools did not differ from their counterparts who went to high performing schools.

4.4 Predicting performance on academic skills by group membership

Discriminant function analysis performed to classify children's performance according to the two school groups. Five academic skills, three on literacy and two on mathematics which came from components after the dimension reduction were used. The table below presents these results.

4.4.1 Discriminant function analysis of school quality on literacy and numeracy skills

Table 7: Discriminant function analysis of school quality on literacy and numeracy skills

Predictor variable	Pooled within-groups correlations between Discriminant variables and standardized Discriminant functions	Univariate $F(2, 98)$
Maths-number sense	.71	4.94**
Reading and writing	-.56	.56*
Maths-number facts	.29	.38
Alphabet knowledge	.19	1.34
Phonemic awareness	-.16	7.99
Canonical R	.37	
Eigenvalue	.16	

***p<.05*

This analysis aimed at testing whether school quality membership predicted learner performance in mathematics number sense, mathematics number facts, reading and writing, phonemic awareness and alphabet knowledge. In order to examine this group membership performance, discriminant function analysis was performed on these five academic skills. Discriminant function analysis appeared to be appropriate for this analysis since all the five academic variable are continuous. Furthermore, the analysis was an adequate technique as it maximizes the differences between the two existing groups on the basis of a set of predictor variables.

On the basis of all five predictors, there was reliable association between the two groups and the predictors, χ^2 (5) = 14.27, p<.05, canonical r = .37, canonical $R^{2\,=}$ *.14.* The canonical correlation (r = .37) is the multiple correlation between all the five predictors and the discriminant function. With only one function, it provides an index of overall model fit which is interpreted as being the proportion of variance explained (R^2= .14). In this study, therefore, the discriminant function accounted for 14% of between groups variability. Of the five correlations with the discriminant function two of them (numbers-sense and reading and writing) showed loadings of .50 and above. The canonical correlation means that the model explains 14% of the variation in the grouping variable, i.e. whether a child belonged to a low performing or high performing school.

The structure (loading) matrix of correlations shows the strength of relationships between predictors and the discriminant function between low performing and high performing schools. This in other words means that the pooled within groups correlations between discriminant variables and standardized discriminant functions indicate indices of importance of each predictor. The positive or negative sign indicates the direction of the relationship, but are disregarded when interpreting the regression weight.

In this study, these results show that mathematics number-sense (r = .71) and reading and writing (r = .56) were primary predictors with loadings of .50 and above.

4.4.2 Discriminant function analysis, descriptives

Comparing dependent variable means, results showed that low performing schools revealed high means on mathematics number facts *(mean = .12, SD = .96).* High performing schools on the other hand scored high on reading and writing (mean = *.27, SD = (1.11).* Results show that the performance of each of the two school categories was not uniformly either better or worse. This means that schools in each group had areas of strengths and weaknesses as high performing schools were not absolutely high in all aspects and low performing schools were not low in all aspects.

4.4.3 Discriminant function analysis of school quality on selected background variables

Table 8: Discriminant function analysis of school quality on selected background variables

Predictor variable	Pooled within-groups correlations between Discriminant Variables and standardized Discriminant functions	Univariate F(2,98)
Working memory	.70	11.14**
Emotional control	.62	8.82**
Plan. and organization	.54	6.71*
Children in other grades	-.48	5.37*
Home literacy	-.30	2.13
Home learning-support	-.30	2.08
Canonical R	.44	
Eigenvalue	.24	

$**p<.05$

The rationale and principles behind the use of the discriminant function analysis on this set of variables, is not different from how it was used in the earlier analysis above in Table 8. The only difference is in the type of dependent variables and the respective outcomes of the analysis which are presented below. Essentially, this analysis was meant to ascertain whether school quality made statistically significant differences to children's performance in three executive function skills (working memory, emotional control and planning and organisation) and three other background variables (children in other grades in the home, home literacy and home learning-support).

Results from Table 8 above show positive and negative correlations between pooled within-groups between discriminant variables and the discriminant function ranging from moderate to high. The whole model is a good fit as it was significant with p-value = .003. Because there were only two grouping variables, one discriminant function was calculated. On the basis of the six predictors in this function, there was significant association between the two groups and some predictors with a combined χ^2 (6) = 20.04, p<.05. The discriminant function accounted for 19% of the total between group difference. The eigenvalue (.24) is moderately high, an indication that this function reasonably differentiates between the two groups.

Results extracted from the structure (loading) matrix between predictors and the discriminant function presented in the Table 8 suggest that the strongest predictor between low performing and high performing schools were working memory *(r = .70).* This was followed by emotional control (r = .62). However, the three dependent variables differed in that executive function skills had positive correlations while the other variables showed negative correlations. In the same vein, the weaker predictors between groups were home literacy and home learning-support (r = -.30) each. In this study, the canonical correlation had yet another important use as it helped to measure the effect size since it is the correlation between the two groups and the discriminant function. This tells us how strong the prediction is in this particular analysis.

Pooled within-group correlations among the six predictors indicate that two of the six correlations (home literacy and home learning-support) did not show any significance, while the other four were statistically significant with $p < .05$. Table 10 above also shows that correlations were quite spread from low to moderate and high with only two of these indicating statistical significance.

4.4.4 Descriptives of discriminant function analysis on background variable

Table:9 Discriminant Function analysis Means and Standard Deviations

Variable	LPS		HPS	
	M	*(SD)*	*M*	*(SD)*
Children in other grades	.48	(.51)	.26	(.44)
Home-literacy	6.04	(2.73)	5.22	(2.89)
Home learning-support	19.34	(4.67)	17.96	(4.89)
Emotional control	3.48	(2.85)	5.22	(3.01)
Working memory	5.80	(5.95)	9.42	(4.84)
Planning and organ.	3.12	(3.22)	4.74	(3.03)

Background variable-means on discriminant function analysis show that low performing schools were rated relatively high on home learning support *(Mean = 19.34, SD = 4.67)*. Children from high performing schools were rated relatively high on working memory *(Mean = 9.42, SD = 4.84)*, while those children from low performing schools recorded were rated low on this variable *(Mean = 5.80, SD = 5.95)*.

4.5 Predicting literacy and mathematics skills

Table 10: Background variables as predictors of literacy and mathematics skills

	Literacy			Mathematics	
	Alphabet knowledge	*Phonemic Awareness*	*Reading& Writing*	*Number facts*	*Number sense*
Background variables	Standardised estimate β				
preschool	.103	-.124	.035	.095	-.321**
Home literacy	-.183	-.049	-.046	-.090	-.153
Learning support	.036	-.090	.105	-.012	.158
Home possessions	.272*	.196	.190	.061	.043
School quality	-.068	.044	.263*	-.090	-.253**
RSA (stress) reactivity	.035	.134	-.179	-.173	.245*
R	*.35*	*.23*	*.38*	*.21*	*.46*
R^2	*.12*	*.06*	*.15*	*.04*	*.21*

A linear regression analysis was performed to predict all the key outcome variables from selected background variables. In this analysis, the researcher was particularly interested in determining the predictive role of preschool, home literacy, home learning support, school quality and RSA (stress) reactivity on literacy and mathematics skills in the first grade. After controlling for other background variables, Table 10 above shows the summary of all the analyses carried out on the selected five academic skills. Some independent variables strong were and positive predictors whereas other were weak on either side as well.

With regard to preschool, results indicate that this variable was a strong and significant but negative predictor of mathematics-number sense *(β = -.321)*. This means that children who went to preschool performed more poorly in mathematics number sense compared to their counterparts without a preschool background. Though not statistically significant, phonemic awareness also recorded a negative regression *(β = -.124),* an indication that preschool was positive negative predictor of phonemic awareness. This puzzling result may indicate that preschool has a negative effect on language proficiency. Both number sense and phonemic awareness make a strong appeal to language skills.

RSA (stress) reactivity was a statistically significant positive predictor of mathematics number sense *(β = .245),* meaning that children who were reactive to challenging situations performed better in mathematics number sense than those who were less reactive. There was a similar finding for phonemic awareness though not statistically significant *(β = .134),* a further indication that children who were reactive to challenging situations performed better.

Other statistically insignificant results seem to reveal that children who were more reactive to challenging situations performed better in reading and writing and mathematics number facts. This suggests that children tend to concentrate when stressed and therefore perform better in the long run.

Home possessions was a significant positive predictor of alphabet knowledge, but remained insignificant on other dependent variables, with moderate betas on phonemic awareness *(β = .196)* and reading and writing *(β = .190).*

Regarding school quality, results revealed that this variable was a strong predictor of reading and writing *(β = .263)* and mathematics number sense *(β = -.253).* However, this prediction is inconsistent with a positive regression weight on reading and writing and negative weight on mathematics number sense. This implies that children who went to high performing schools performed better in reading and writing than their counterparts who went to low performing schools. With regards to mathematics number sense, results indicate that children who went to high performing schools did worse than those who went to low performing schools. In this case, school quality was a strong and positive predictor of reading and writing, but was a negative indicator of mathematics number sense. Schools do not seem to balance the teaching attention to the two academic skills. Teachers at low performing school seem to teach more mathematics skills compared to their counterparts at high performing schools who seem to concentrate more on the teaching of reading and writing.

Mathematics number sense was best predicted by *(R^2 = .21)*, suggesting that *21%* of the variance is attributed to the set of predictors. School qualities (preschool and school quality) were negative predictors whereas being reactive to stress was a positive predictor

4.6 Predicting RSA (stress) reactivity from child characteristics and mathematics skills

Table 11:Predicting RSA (stress) reactivity from selected variables

Variable	Standardized estimate β	t	*p-value*
Preschool	.365**	2.906**	.005**
Home possessions	-.160	-1.304	.196
Maths number-facts	-.156	-1. 549	.125
Maths number-sense	.247*	2.361*	.021*
Model statistics			
R	*.38***		
R^2	*.14***		

In order to establish the extent to which some selected variables (namely, preschool experience and home possessions) predicted RSA (stress) reactivity, another linear regression analysis was performed with the four variables which were singled out as predictor variables. The analyses aimed at identifying potential underlying factors that may relate to RSA (stress) reactivity in children. The basic assumption was two-fold. Firstly it was assumed that negative home-circumstances such low social economic status (SES) can induce stress. On the other hand, poor performance in mathematics skills was also assumed to lead to stress reactivity. In both cases, individual differences were likely to heighten or suppress the stress reactivity.

Based on these assumptions, a single-model regression analysis was conducted to predict RSA from preschool, home possessions, number facts and number-sense. Results indicate that preschool and mathematics number-sense were strong predictors of RSA (stress) reactivity *(β = .356* and *β = .247),* with positive regression weights respectively. This simply implies that children with a preschool background and performed high in mathematics number-sense scored high on the reactivity scale meaning that they were able to regulate their stress level. because decrease in RSA relates to high reactivity and increase in RSA relates low reactivity. Home possessions and mathematics number-facts on the other hand recorded negative regression weights *(β = -.169* and *-.156),* respectively. These results suggest that children from homes with more home-possessions (high SES) scored low on RSA (stress) reactivity and did not adapt so well during challenging situations. This behaviour and reaction negatively influenced their learning and later performance in academic skills because failure to react to stressing conditions would lead to failure to engage profitably in academic skills.

4.7 Summary

As predictors of early literacy, preschool and home possessions have been associated with alphabet knowledge, and not other academic skills. School quality on the hand was a strong predictor of reading and writing as high performing schools were high on this variable. However, on the mathematics number-sense variable, low performing schools were better, suggesting that instructional practices differed from one school type to another. Contrary to what was hypothesized, such this difference over-rules the general assumption that children at high performing schools record a better in all academic skills while children attending low performing schools do worse in all academic skills. It is also clear that low performing schools are not low in all aspects just as high performing schools are not in all aspects. The performance of a schools could be determined by other internal factors. The combination of both child characteristics and home circumstances get influenced by a hoist of school factors thereby giving rise to the type and quality of literacy and numeracy skill attainment.

CHAPTER FIVE

5.0 DISCUSISION OF FINDINGS

5.1 Overview

This chapter discusses the findings of the study which examined the differential effects of child-characteristics, home factors and school quality in view of how they influence early literacy and numeracy skill-attainment in the first grade. The discussion is presented with reference to literature relevant to this study. In order to address the effects of these factors, some issues were raised. These were: the role of background variables on literacy and numeracy skill attainment, associations among background factors such as home literacy, home learning support and home possessions and literacy and numeracy outcome variables. Background and outcome variable-differences on school quality, the influence of child-characteristics and home factors on literacy and numeracy skills, home factors and preschool influence of literacy and numeracy skill-development, school quality and its effect on literacy and numeracy skill-attainment, RSA (stress) reactivity and executive functions as predictors of literacy and numeracy skills and lastly selected variables as predictors of RSA (stress) reactivity. The issues outlined above constitute the sections through which this chapter is organized.

In this study, background variables included child-characteristics (age, preschool, RSA stress reactivity, and executive functions). Home factors on the other hand related to the child's home-experiences and opportunities, relationships which have a direct influence on the child, which included: home possessions, home literacy and home learning-support. School quality was another background variable which in the context of this study refers to the nature of a school, described as either a low or high performing school from which the sample of the study was drawn.

The study's outcome variables were five in total. These included: reading and writing, alphabet knowledge, phonemic awareness, mathematics number-facts and mathematics number-sense. These variable were arrived at through the dimension reduction which was performed earlier with the view to reduce the amount of data.

5.2 The role of background variables on literacy and numeracy skill-attainment

A number of studies have shown the influence of background factors on literacy and numeracy attainment. The study's aim was mainly to find out whether school quality, preschool, socio-economic status, home literacy, home learning-support and executive functions contribute to the attainment of early literacy and numeracy skills among Zambian children in the first grade. This study also sought to establish how children who are easily stressed could perform in early literacy and numeracy if they attended schools with weak (low performing schools) or strong (high performing schools) didactics. In Zambia, some primary schools are perceived and described two ways as either good or poor schools. This description is based on the general performance of learners in national examinations. School quality was a grouping variable which helped to group children and their performance.

Since the study focused on children in the first grade, the aspect of executive functions (EF) was of crucial importance. Davidse (2014) observes that most studies on the effects of executive functions on numeracy and literacy development focus on preschool and kindergarten. In this issues, influence of executive functions, therefore, was also anticipated in this study given the need for cognitive and regulatory skills that go with the development of early literacy and numeracy skills. The performance of children in this study from both low and high performing schools was prompted by the main research question 'Why do most young learners in Zambian public primary schools fail to acquire and attain acceptable grade-level literacy and numeracy skills despite efforts undertaken to improve the teaching and learning of these skills by the Ministry of Education?' Based on this question, various child-characteristics and several home factors were examined in order to establish their effect on early literacy and numeracy in the context of school quality.

As already suggested, several studies have shown that early literacy and numeracy skill-attainment is influenced by a number of factors. Some of these factors directly relate to the child while others relate to the child's home and school environments. A study by Domblewski and Kauffman (1990:21), for example, noted that "parents serve as their children's first and most important teachers and role models. Therefore, creating a learning environment and atmosphere in the home in which learning can take place is one of the major responsibilities of care-givers. A stimulating and safe environment can increase the child's socialization and learning opportunities within and outside the home. Such an atmosphere is marked by parents' or care givers' willingness to assist the child in various ways and most importantly in learning. Responsible care-givers can nurture a child's mental development by seeing to it that the growing child has a variety of stimulating experiences in the immediate surroundings.'

Emphasing the importance of the environment to literacy attainment with reference to the South African context, Bloch (2005) indicates that, majority of children in Africa grow up in 'print scarce' as opposed to 'print rich' environments and this might be a contributing factor to literacy behaviours. This is not the only factors, but one of the major factors which affect children's success in literacy attainment.

The current study established an association between home literacy and home learning-support. This means that children who came from homes were reading was encouraged also received some kind of support from significant others in the home. Despite the fact that home literacy correlated so strongly with home learning-support, results on the contrary showed poor correlation with shift and emotional control. Planning and organisation on the other hand showed some negative association with school quality. This result suggests that children who went to high performing schools were less able to plan and organize their activities properly. This finding simply means that older children were better at executive functions than their younger counterparts as executive functioning has a lot to do with maturity which is usually age-related. Though not always the case, it is expected that the older the child, the more mature and more ready a child would be for school.

The study also revealed that school quality correlated strongly with reading and writing abilities, accounting for 22% of the variance. This result shows that high performing schools did not completely give positive results in all outcome variables which in the context of this study confirms the possibility of the influence of individual variations to school-outcomes despite all factors being equal and present.

Parents at home and teachers at school share the responsibility of taking care of children's general well-being and learning. The only difference is that parents do it generally and informally while teachers take their responsibility formally and professionally. Effects of what is done to the child has long-term consequences on the child, hence the need for lots of research on the role of parents and teachers on child development and early literacy and numeracy learning. For this reason, parents and teachers need to regard each as stakeholders playing complementary roles on the child. Teachers' abilities to support social and emotional functioning of every child in the classroom are, therefore, central to any conceptualization of effective classroom practice. Every teacher should ensure that all children in their school or classroom, regardless of their background and personal characteristics are physically and psychologically safe for them to benefit from school.

5.3 Associations among background and outcome variables

After exploring the background variables, different learning opportunities and possible risk factors were examined. In the light of the differential susceptibility theory, the study established a number of interesting findings which have been presented later.

In this study, there was a significant association between age and mathematics number-sense implying that older children performed better in mathematics number sense. A negative association was, however, also observed between age and home possessions, implying that younger children came from homes with more possessions. The age and mathematics number-sense showed a positive significant correlation accounting for 4% of the variance. This fining is an indication that children need to be enrolled in school when they are mature enough.

In terms of preschool, younger children had a privilege of more often attending preschool. The explanation is that for the children who attended preschool, their parents judged school readiness by the number of school related activities that their children were able to participate in. Therefore, this prompted these parents to take their children to start school early. This assertion is concretized by the Early Childhood Development Project. Zuilkowski, Fink, Moucheraud and Matafwali (2012) found that participation in ECE does not only improve academic outcomes but also encourages a timely enrollment of children in grade one.

Preschool and home possessions on the hand indicated were negatively correlated, meaning that older children did go less often to preschool and came more often from homes with less home possessions which can also be described as low SES homes.

Supporting practical associations between numeracy skills and executive function (planning and organisation), Mercer and Mercer (1993) state that daily living requires numerous math skills, for example planning and monitoring time, shopping, computing percentages, estimations among others. Cognitive factors are needed as the child progresses from lower level math-skills to higher order ones. In this case, the concept of learning readiness in math instructions is of crucial importance. Readiness with mathematics has a lot to do with age as mathematics skills need a lot of focused attention, organization, recall and concentration. In the school setting or classroom setting, children need to follow a lot of instructions for them to benefit from mathematics instructions and teaching. If attention regulation is essential for developing early academic skills, one might expect that children who experience difficulties with ignoring distractors will also have more difficulties acquiring early literacy skills such as letter knowledge (Lonigan et al.,1999).

Regarding the emergence of mathematics number-sense, Dehaene (2011) indicates that even in the first weeks of life, when babies see a constant number of objects, they look longer when the display changes from say 8 to 16 objects. This view suggests that the concept of mathematics number-sense has more to do with in-born characteristics than with environmental experiences. From this point of view, the present study established that children who went to low performing schools did better at mathematical number-sense than those who went to high performing schools. A significant difference was also noticed for alphabet knowledge and reading and writing.

As revealed by this study, it is possible to assume that reading and writing achievement is associated with facilities and provisions in the home and school environment. However, this argument is not totally in agreement with Matafwali (2010) who established that the literacy levels of a majority of

Zambian children were remarkably low despite having a rich literacy programme in place. Matafwali's view seems to emphasise there are other factors that need to be addressed other than the formulation of a programme and supply of material. This observation is timely because formulating a rich curriculum does not guarantee its benefits, if it is not well supported and implemented.

In another study conducted on 60 grade two poor readers (identified by teachers) from selected schools in Northern Province, Kalindi (2005) argues that only 13% could read two syllable words, and only 8% could identify 20 letters of the alphabet. With these study findings available, it is worth noting that the quality of instructions especially in foundational years of children need to be in harmony with curricular preparations. Furthermore, following many changes in the language policy and guidelines, inconsistency in pre-service teacher-training and in-service orientation has had a negative effect on children's early literacy and numeracy skill attainment. Even if children come from supportive home environments, it is not always the case that those children would perform better in schools, a view which seems to suggest why Zambian primary schools continue to record persistent low performance among young learners. It can be argued that the home and school environments influence part of children's literacy and numeracy learning, but the school seems to be more influential position.

Despite the study anticipating some related performance trends on both numeracy and literacy skills, it was surprising to note that reading and writing indicated a negative correlation with mathematics number-sense ($r = -.20$ which accounts to 4% of the variance. This variation indicates that children who performed well on reading and writing had difficulties with mathematics number-sense. This was a unexpected finding given that high performing schools were expected to give an overall picture of being high achieving. This finding is contrary to Davidse (2014) who asserts that "within the school curriculum it seems important that teachers are aware of the fact that delays in literacy often go together with delays in mathematics and vice versa", which was not the case in this study as children who performed well in reading and writing performed poorer in numeracy than expected.

As already alluded to, the negative association between performance in literacy and mathematics could be attributed to other factors such as imbalance between teaching time allocation on the lesson time-table. Furthermore, it is possible that teachers' attitudes and preferences to teach one subject with a higher frequency than the other could be another factor. If teachers do not teach all subjects as prescribed, children would be at risk with skill development and future progression. This is so because young learners need initial basic skills upon which they build in future.

In the Zambian education system, a gap between the college of education curriculum and the primary school curriculum seem to exist. This has been noticed through college-student reports after teaching practice in schools, which is the practical part of their training. Some schools are reported to have different methods and approaches of teaching compared what students are taught in colleges of education. This indicates that the education system between primary and college levels still has some variations which should be reconciled if teachers are to be well trained. Failure to do so, the effects of schools on literacy and numeracy dimensions will remain different.

In terms of phonemic awareness and mathematics number-facts, the study showed a significant but moderate correlation, accounting for 5% of the variance. This result implies that children who scored high on phonemic awareness also did well in mathematics number-facts. This was expected as research acknowledges the relationship between mathematics and phonemic skills. Dehaene (2011), for example, states that numbers are stored as language in the human brain and the preverbal representation of numerical quantities probably plays a crucial role in this process. From this perspective, it is clear to note that there are psychological connections between mathematics and language aspects, hence the teaching and learning of these aspects cannot be separated. It is then possible that children who struggle to learn literacy skills are likely to face difficulties in one way or the other in the learning numeracy skills.

5.4 Selected background variables as predictors of literacy and numeracy outcomes

Internationally, a large body of research has demonstrated that early childhood education, commonly referred to as preschool can prevent early academic failure and that it has positive long-lasting effects throughout the lives of children from poor families (e.g. Boocock, 1995; Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Myers, 1992). One of the background variables of interest was preschool attendance among others.

This study focused on five outcome variables which included: reading and writing, alphabet knowledge, phonemic awareness, mathematics number-facts and mathematics number-sense. Notwithstanding the globally acknowledged importance of preschool, there was no association between preschool attendance and four of the outcome variables. A positive but weak correlation was only noticeable between preschool and alphabet knowledge while there was a negative significant correlation between preschool and mathematics number-sense. This results indicates that children who went to preschool were not any better than their peers who did not attend preschool. With this result, one questions whether preschool is always a predictor facilitates school readiness by predicting positively literacy and numeracy skills.

From the results of this study, one would doubt the role of preschool in both literacy and numeracy development. The current study only revealed that children who went to preschool were good at alphabet knowledge compared to children who did not go through preschool before they entered their first grade. Even this proficiency in alphabet knowledge may not be absolutely attributed to preschool as other factors like home possessions also had a positive correlation with alphabet knowledge. The failure by preschool to strongly associate academic skills (literacy and numeracy) is inconsistent with most research findings. This should be a matter of concern among researchers and policy makers on how preschools can facilitate academic skills development in young learners. The study, therefore, seems to suggest that despite preschool being an important provision for children into school, preschools in Zambia do not seem to adequately prepare children for learning basic literacy and numeracy skills. A number of other reasons could be behind this poor performance outcome, but the low quality of service at preschool being the most obvious.

A linear regression analysis was also conducted to assess the predictive role of preschool, home literacy, home learning support, home possessions, school quality and RSA (stress) reactivity on literacy and numeracy skills. It was anticipated that children who came from homes with few home possessions would not perform as well as their counterparts who came from homes with more home possessions. Not surprisingly, therefore, results show that home possessions strongly predicted alphabet knowledge. This implies that children from high SES homes (homes with more home possessions) had an advantage over those from low SES home (homes with less home possessions) in alphabet knowledge. A possible explanation for this is that children from high SES home had access to play-toys, children's books, television, videos, radio and other modern gadgets that stimulated initial literacy skills which could be associated with alphabet knowledge. It is also true that children who came from homes with more home possessions (high SES) had access to preschool and schools they went for preschool provided a number of items with which to play. All these opportunities put together, would certainly give an advantage to develop alphabet skills.

In the context of the present study, since children who attended preschool came from homes with more home possessions (high SES), it implies that preschool was more accessible for children from richer families. Surprisingly, the performance of children was very low in mathematics number-sense. This finding is contrary to expectation as preschool is generally expected to give an advantage to children in the first grade. Several studies confirm positive expectations, for example, Feldman (2004: 281) reveals that “Preschools, also known as nursery schools, are more explicitly designed to provide intellectual and social experiences for children. Because they tend to be more limited in their schedules, typically providing care for 3 to 5 year-olds, preschools mainly serve children from middle and higher socioeconomic levels.” However, the quality of preschools differs significantly from one country to another.

Whist the guiding rationale behind preschool is basically child preparation, it would be necessary to critically examine possible factors that distinguish preschool settings. For the present study, results show that children who had been to preschool did not seem to have an advantage in mathematics number-sense compared to their counterparts without a preschool background. , Preschool attendance did not significantly predict phonemic awareness. The study has clearly revealed that not only was there no association between phonemic awareness between preschool and phonemic awareness but preschool had failed to also predict other literacy skills such as reading and writing.

As already alluded to, this poor performance with regards to preschool could be attributed to the low quality teaching-instructions in most preschools in Zambia. Furthermore, this quality of teaching can also be linked to the quality of teaching in primary schools since preschools and first grades are only a year apart. If the two learning levels - (preschool and first grade) record low performance, it can be strongly assumed that the quality of teaching is generally low as grade 1 children fail to get enough instructions to demonstrate grade-level knowledge of literacy and numeracy. This finding is consistent with Matafwali and Munsaka (2010) who reveal that a majority of preschool teachers in Zambia are not trained hence they may not have the required skills and knowledge to teach.

Regarding the general low literacy levels, in Zambia, Jere-Folotiya (2014) reports that performance over the years of Zambian learners in Mathematics and Reading as being consistently low, with negligible improvement. Therefore, her study acknowledged the need to seriously explore the role of a teacher within the context of low literacy acquisition.

Another variable of interest among home-factors was children in other grades in the home. It is a common expectation that most Zambian families are large given the number of siblings people have. In this study, it was noticed that 37% of the children came from homes where they had other children in the home in other grades. This does not mean that the remaining children came from homes without siblings. It is very possible that some of the other children came from homes where some siblings were not in school. This is typical of average Zambian families especially in rural settings.

On the other hand good number of children (71%) also indicated that they lived with their own biological parents. Relationships with the child were understood in the context of whether a child came from a home where there were biological parents. It was established that children who had siblings in other grades came from homes with biological parents. The same children also seemed to enjoy home literacy and home learning-support. Surprisingly, however, children from homes with more children were poor at emotional control and Mathematics number facts. This result shows that failure to control one's emotions would lead to frustration and lack of concentration as mathematics number sense requires a ready, motivated and stable mental state. It is clear then that children who came from homes with more children enjoyed opportunities of social interaction facilitating play but experienced some challenges as well when it came to emotional control.

Although homes with high SES offered literacy opportunities, it would have been expected further that children from such homes could have demonstrated more proficiency in other academic skills in addition to alphabet knowledge. This was not the case however, The failure for home possessions to predict beyond alphabet knowledge, confirms the low quality of preschools and learning facilities to address core learning needs. It is also clear that children from low SES homes most of whom presumably had limited or no access to similar facilities in their home environment could not benefit from such provisions, hence their poor performance even in alphabet knowledge. Home possession only accounted for 7% variation.

Regarding phonological awareness, the study revealed that none of the background variables was a strong predictor of this outcome. The quality of teaching in schools does not really to address phonemic awareness because after children had been in the first grade for almost one year, there was no prediction from any of the background variables. Furthermore, home possessions attempted to give a prediction which was not significant at all. Failure for any background variable to predict phonemic awareness has more to do with teachers' knowledge and instruction of phonological awareness skills. Teachers' lack of phonological awareness teaching skills is closely associated with the nature and quality of training available in primary colleges of education this was failure to predict phonemic awareness was also noticed in both low and high performing schools. Phonological awareness does not seem to be emphasized during training. Consequently, teachers in schools failure to transfer this knowledge to children in order to prepare the children for literacy skill development.

Both-de Vries (2006) holds the view that phonemic awareness can only be acquired when children have support of the orthography. This view suggests that preparation of teachers on how best to teach early literacy and numeracy to young learners needs a lot of consideration. In this case, it would be important to establish how well classroom teachers understand the conceptual and skill component of phonological awareness and the general aspects of literacy teaching methods to be used. This is necessary because, to have the curriculum and methodology guidelines on paper is one thing and to apply these methods correctly is yet another aspect.

Although the present study did not specifically investigate on the influence of colleges of education with regards to the teaching of literacy and numeracy, suffice to say initial quality teacher training and retraining in early literacy and numeracy teaching methods appears to be a critical missing link. This stands to be true as the researcher taught at a primary college of education for more than five years. Given the many changes that have been introduced in Zambian primary school system, teachers do not seem to be sure of effective methods of teaching. If this trend continues, it may seriously affect the teaching and learning of early literacy and numeracy. This study clearly revealed that reading and writing was only associated with high performing schools. It is widely acknowledged that phonological awareness is a strong predictor of reading and writing skills.

The strength of high performing schools is exhibited in the reading and writing variable although it was found that children who went to such schools had difficulties with mathematics number sense. In a positive sense, there was a positive association between phonemic awareness and mathematics number-sense. Although the study recorded poor performance on phonemic awareness, it on the other hand indicates that children who were good at phonemic awareness were also good at mathematics number-sense. Matafwali (2010) shows that substantial empirical evidence has now been accumulated which demonstrates a definite relationship between phonological processing and eventual success in reading.

There is very strong evidence from correlational and interventional studies for a causal link between phonological processing skills and reading achievement. Form evidence through this and other studies, it can be argued that poor performance in language and phonological awareness can lead to difficulties in reading and writing. The National Reading Panel (2000) states that reading is influenced by a number of interacting factors. One of these factors is phonological awareness which is awareness of phonological units represented by a given writing system which is positively correlated with reading ability. Elbro, Bostron and Peterson (1998) also revealed that phonological awareness follows a developmental schedule, with awareness of syllables developing before awareness onset which in turn develops awareness of phonemes. This awareness of phones and the ability to reflect on and manipulate them increases the chances that young children will develop good decoding skills leading to success at reading from early grades.

Noe et al (2014), however, note that despite attendance in preschool and the potential of emergent literacy skills to build a foundation for reading, many children do not receive sufficient emergent literacy instruction early enough. In view of the present study the opportunity of most Zambian children to become better readers is influenced by an interplay of factors within the child, in the home and schools. This implies that placing a child in a high performing school does not automatically guarantee academic advantage and success at all as the consistency of quality instructions and appropriate learner-support in a stimulating environment has a lot of influence on learners-achievement. Therefore, if not well developed in learners, the lack of these skills would lead to poor literacy skills development in early schools and later in children's life.

5.5 Home factors and their influence on literacy and numeracy skills development

The importance of home factors in influencing children's literacy and numeracy skills in young learners has been one of the growing topics of current research. Research findings indicate that children from low-income backgrounds do not receive exposure to literacy enhancing activities in the home setting (Feitelson & Goldstein, 1986). The relationship between low socioeconomic status and reading achievement is likely mediated by language (Hart & Risley, 1995). Foster et al (2005) have also recorded that the quality of the home environment is widely recognized as a strong contributor to young children's emergent literacy and social competence and to their subsequent educational success.

A study by Burgess et al. (2002) revealed that the home literacy environment played a crucial role in the development of emergent literacy skills, with storybook reading as one of the most significant home learning activities to increase literacy skills. Furthermore, Forget-Dubois, et al. (2009) revealed that home environment quality is a well-known predictor of school readiness (SR), although the underlying processes are little known. School readiness (SR) is a multidimensional construct that includes behavioral, emotional, cognitive, and knowledge components that make the child ''ready to learn'' at school entry (Blair, 2002; Chew, 1981).

This study established that home possessions was a strong predictor of alphabet knowledge and was moderate on phonemic awareness and very weak on reading and writing. In the Zambian context, one possible reason why home possessions could not positively associate with home support could be that most parents in the high SES class take their children to the socially perceived high performing schools where it is expected that there is good teaching. Based on this seemingly good perception about high performing schools, some parents do not spare time at home to help their children with school work in areas of need. With reference to available research evidence on the importance of home literacy experiences, this study sought to establish whether this was the case for Zambian children who went to low and high performing schools. Studies of the child's home learning environment have repeatedly shown that the learning experiences with the parent have direct and significant associations with children's cognitive and emergent literacy competence (Dickinson & Tabors, 2001). It is important to observe that the quality and consistency of learning experiences in the home have a lot of say on the performance of learners.

Pluess and Belsky (2010) have observed that whether, how, and to what extent parenting affects child development has been of longstanding interest to developmental psychologists and family scholars. Consequently, a vast diversity of empirical work has been conducted of late with different strands of research in human development providing strong evidence for links between parental rearing practices and child outcomes. A substantial number of studies, show that some children are more susceptible to both negative and positive parenting experiences than others just as the differential-susceptibility hypothesis would predict.

The notion that children may respond differently to similar experiences and therefore limit the variance accounted for by shared-environment in genetically informed studies is certainly consistent with research on the interaction of temperament and parenting in predicting child development, including work indicating that children with certain temperamental traits are more adversely affected by negative environmental conditions than are others (Belsky, Hsieh, & Crnic, 1998).

In the Zambian situation the 'so called better schools' are usually associated with social prestige where parents in middle or high socioeconomic status groups prefer to take their children. Such schools have better facilities than those found in other schools which are perceived to be of lower standards. For this reason, high performing schools are competitive in terms of children's school places as parents expect a better quality of education from them. Considering the salience of language and literacy in our society, learning to read may be the most important achievement in children's lives (Neo et al, 2014). As revealed by the present study, children from homes with low home possessions got more frequently enrolled in low performing schools. This study, therefore, established generally that families with high SES were associated with high performing schools while families with low SES were identified with low performing schools.

Furthermore, the present study indicated that children who come from homes with more home possessions were better at alphabet knowledge, but were rated poorly on emotional control. These children had also been exposed more often to preschool which was also associated with well-to-do families. In terms of age it was established that older children did not attend preschool and came from homes with low home possessions. Such children, however, scored as good on mathematics number sense and higher on working memory.

In addition, Paradowski (2007) declares that children's growth from emergent to conventional literacy is influenced by their understanding of literacy concepts and efforts of parents, caregivers and teachers to promote literacy. In this case, both home and school circumstances which can provide either supportive or un-supportive experiences to children are important aspects in exploring the role of the home environment. Children reared in home settings where there is less support are more likely to suffer from social, psychological and academic challenges. These challenges can lead to poor emotional control and high stress reactivity levels.

RSA (stress) reactivity has far reaching consequences in academic performance of learners. The present study's regression analysis shows that school quality and RSA (stress) reactivity were negative predictors of mathematics number-sense. The predictions of RSA (stress) reactivity on reading and writing and mathematics number-sense appeared to be rather moderate but insignificant, an indication that children were not so reactive when faced with a challenging situation. It would interesting to explore further reasons for such a finding.

Children's living and learning environments are multi-faceted. In this regard, Tough (1979:53) argues that, "the role played by adults in children's learning is crucial. Unless children have experiences of interaction with adults who draw them into particular ways of thinking through talk, they may not fulfill their potential for thinking and using language. For some children, however, the teacher is the only adult they will meet regularly who will have the resources and insight into children's learning to fulfill this role. Myers (1998) states that by observing and imitating models, we learn all kinds of social and academic behavior. As demonstrated in this study, the influence of a teacher on a child is partially determined by the amount of skills both academic and non-academic which a teacher may pass on to the learners. It is an indisputable assertion that when a heterogeneous group of children struggle or completely fail to develop literacy and numeracy skills after being in school for almost one year has more to do with the school environment and the quality of teaching rather than the home environment. Contrary to expectation, the performance of children in this study was generally poor regardless of children coming from different homes some of which provided a lot of resources and learner support. Even without learner-support, high performing schools were supposed to record some significant predictions on phonemic and mathematics number sense, however, this was not the case.

Ramey and Ramey (1994) on the other hand state that families with low socioeconomic status often lack financial, social and educational support that characterize families with high socio economic status. Poor families especially, have inadequate or limited access to financial, material, social and human resources that promote children's development and school readiness.

Presley (2002) further argues that cognitive development moves forward most certainly and completely if the child is in the world that provides assistance when the child needs it and can benefit from it. In particular, responsive and responsible adults spend a great deal of time talking with their children about things that happened to the child, assisting the child in learning how to be tellers of their own memories. Such social and natural skills have a lot in common with executive functions which include: inhibition, planning and organization, working memory, shift and emotional control.

Socioeconomic status at family level has also been linked to children's school achievement. Damarest et al (1993) show that families with high socioeconomic status often have more success in preparing their young children for school because they typically have access to a wide range of resources to promote and support young children's development.

The present day study established a contrary view, however, as learner-support had no correlation at all with home possessions, a variable that represented SES. It was also interesting to note there was a significant negative association between home possessions and emotional control, implying that children from middle and high income homes were poor at controlling their emotions.

It is also worth noting then, as revealed by this present study that most Zambian families' living circumstances are characterized by low socioeconomic status and poverty, a situation which can affect children's health, psychopathy and intelligence. Illiteracy at family level may also be associated with the low socioeconomic status, poor parenting as a good number of parents and caregivers would have very little or no quality time for their children. The home environment to a great extent regulates a child's learning behavior and capacities. School achievement has equally a lot of influence on the behaviour of the children for better or for worse. However, not all children would be influenced by the school. This is so because each child is an individual and might respond to the environmental circumstances differently.

Emphasing the importance of the environment to literacy attainment in South Africa , Bloch (2005) indicates that, majority of children in Africa grow up in ‘print scarce’ as opposed to ‘print rich’ environments and this might be a contributing factor to literacy behaviours. This is not the only factor, but one of the major factors which may affect children’s success in literacy attainment.

The results also showed that despite both mathematics number-facts and mathematics number-sense are mathematics aspects, children’s performance was different. There could be several possible reasons for this discrepancy. As children learn mathematics, they are likely to find certain concepts more challenging than others. It is also possible that teachers may not teach all the topics efficiently as they would be as interested in certain topics as their children.. Teachers, therefore, need to be mindful of how they teach and attend to different learners on a number of pedagogy practices in the classroom. Individual differences in terms of learner-abilities, behavioural characteristics and home circumstances are at the centre of directing how children learn and react to what they learn. As such, teachers need to provide differentiated instructions so as to take care of learner individual differences on the basis of home circumstances, personal characteristics and susceptibility.

5.6 School quality and its influence on learners in literacy and numeracy skills

The quality of instructions and facilities in a school has a telling effect on the performance of learners. In the context of this study, school quality meant that either a school was categorized as a low or high performing school. In the regression model used, school quality proved to be a strong predictor of reading and writing. Although school quality positively predicted reading and writing, It was surprisingly to note that it did not predict any other academic skill. This finding was not expected as it was anticipated that children who go to schools with high didactics would do better in literacy and numeracy than those who attend schools with weak didactics. Base on this hypothesis, school quality was expected to predict all literacy and numeracy related variables. This, however, was not the case and such a finding suggests that learning at either low performing schools and high performing schools was affected by a number of factors as evidenced by this unexpected finding.

Regarding the same variable, bivariate correlation findings also revealed that school quality was significantly associated with reading and writing and accounted for 5% of the variance while mathematics number-facts and number-sense had a negative correlation. This is further confirmation based on this study's findings that children who went to high performing schools did better in reading and writing but were poorer at mathematics number-facts and number-sense. This difference in performance on the two outcome variables indicates that the two types of schools did not offer balanced instructions in as far as teaching is concerned. It is also possible that the academic progress children make in school depends on other factors some of which may enhance or hinder the attainment of skills. From this assertion, it is possible that some child-related and home-related factors have a lot of influence on academic outcomes. Costa (2001:229) observes that, "economic realities create cause and effect patterns of thinking and behaving. When people are living in poverty, they devote a great deal of time to survival." Therefore, raising a child in a poverty stricken home-setting is challenging. Domblewski and Kauffman (1990) further note that the demands of parenthood require that a person puts the needs and wants of a child before his or her own. It can also be argued that notwithstanding this social advantage, having many siblings in the home predisposed such children to poor inhibition, shift and emotional control..

As already stated, the Differential Susceptibility Theory was employed to further investigate the predictive role of stress reactivity to children's early numeracy and literacy skills attainment. Similarly, Van der Kooy-Hofland et al (2011) have suggested that stress reactivity is better conceptualized as a high biological sensitivity to context. From this theoretical perspective, children with heightened biological sensitivity to context are predicted to be more vulnerable to negative and stressful contextual factors, but also to have greater capacity to benefit from positive environmental influences.

As already alluded to, the current study indicates the possibility that better teaching of reading and writing could be associated with high performing schools and not so much with low performing schools. Children who go to high performing schools, are likely to attain better reading and writing skills because better schools in Zambia seem to be identified with children's ability to read and write. Although most teachers in Zambian primary schools tend to engage children to independently copy and solve mathematics tasks written on the chalk board, its teaching is not as emphasized as it is in high performing schools. Literacy tasks are more deliberately taught to learners and this calls for a lot of teacher commitment.

5.7 RSA (stress) reactivity and executive functions as predictors of literacy and numeracy skills

Behaviour in the classroom among learners could be attributed to a number of factors. Some recent studies have shown a link between stress reactivity and learning outcomes. Obradovic et. al. (2010) argue that every day, in all human societies, children are exposed to challenging or stressful events from multiple sources. These events range from normative, potentially positive events, such as forming a new peer group; to adverse events, such as witnessing marital conflict; and truly traumatic events that directly threaten children's well-being, such as abuse and neglect. Children respond to these stressors with a set of highly integrated, neurobiological stress responses. Because learners are different, individual attention should be available to all needy learners.

In this study, RSA stress reactivity and executive functions (EF) were thought to be skills that regulate behaviour and cognition to determine Differential Susceptibility. In addition, this study also is based on RSA as one of the background variables. RSA has been regarded as an index of children's capacity to regulate responses to positive and negative environmental demands (Beauchaine, 2001; Beauchaine, Gatzke-Kopp, & Mead, 2007; Porges, 2001, 2003, 2007). High levels of basal RSA have been associated with social competence, empathy, and emotion regulation (Beauchaine, 2001; Eisenberg et al., 1995; Fabes, Eisenberg, & Eisenbud, 1993; Fox & Field, 1989). Low basal RSA, on the other hand, may indicate emotional liability and dys-regulation and has been linked to behavior problems in at-risk or clinical samples. This simply means that children who are reactive to stressful situations register low RSA levels while those who are not reactive show high RSA indices. This is so because when a person is under stress due to some environmental situation, the heart beat-rate increases leading to more inter-heart beat intervals (IBIs). On the contrary, when a person is not under stress, the heart rate is maintained where there are few IBIs between the positive and negative experiences. High RSA (stress) reactivity is usually associated decrease in RSA score and with more learning and increased engagement in learning. On the other hand, low reactivity leads to increase in RSA (stress) and less attention and engagement in learning, an assertion which this study seeks to demonstrate.

The current study result's revealed that RSA (stress) reactivity was a non-significant predictor of reading and writing ($\beta = -.179$) and mathematics number-facts ($\beta = -.179$). On mathematics number-sense ($\beta =.245$), however, RSA (stress) reactivity appeared to be significantly strong. meaning that children who were reactive to challenging situations performed better in mathematics number-sense than those who were less reactive. There was a similar finding for phonemic awareness though not statistically significant *(β = .134)*, a further indication that children who were reactive to challenging situations performed better on this variable.

A bivariate correlation for the same variables revealed a similar pattern of results as from the regression. The associations between reading and writing and mathematics number-facts were *(r=-.182)* and *(r=-.157*), respectively and mathematics number-sense was *(r= .178.)* All the variables (reading and writing, mathematics number-facts and mathematics number sense) accounted for 3% of explained variance each.

Executive functioning may be related to normal reading and writing development, but the relationship of executive functioning to typical reading development has received scant research attention (Sesma et al., 2009) and this is especially so in Africa. In literary research, executive functions are known to predict early literacy skill development (MacClleland 2007). From the perspective of writing, executive functions have been defined as control processes that guide the self-initiation of thoughts, affect and behaviors used to attain writing goals (Zimmerman & Risemberg, 1997). Executive functions monitor recursive planning, translating, and reviewing/revising processes in the problem-solving process of writing (Hayes & Flower, 1980), making them key predictors in mathematics skills as well in addition to reading and writing. In addition to predicting literacy skills, executive functions have also been described as strong predictors of numeracy performance. In their study, Davidse, de Jong and Bus, (2013) found that all academic skills correlated moderate to strong, indicating that development in mathematics tends to go together with development in reading. This finding is inconsistent with the general view of this study, in that high performing schools which did better do well in other skills took a lead in reading and writing.

The study revealed that older children were rated better at working memory and mathematics number-sense compared to their younger counterparts. These children also registered other associations which were not, however, significant with the rest of executive functions. This implies that older and mature children are better behaved, self-controlled and more likely to be organized than younger learners who may not regulate their behavior very well in the classroom. Learning mathematics demands maturity and the capacity to store information and working memory is an essential skill to facilitate this achievement. This cognitive process helps learners to remember and connect information. Young and immature children would have lots of challenges, hence their low performance on these variables. This is so because mathematical processing skills and phonemic awareness use similar cognitive processes.

According to Government policy in Zambia, children are supposed to enroll in the first grade at the age of seven years. However, some parents take their children for preschool and such children are rushed in the first grade even before they are cognitively ready to get to grade one. This is why some children struggle to learn and fail to make expected grade-level progress in literacy and numeracy even though they claim to have been to preschool.

Given this background, the role of executive functions in enhancing early literacy and numeracy skills development can be emphasized. In her study, Matafwali (2010) also contends that reading as a skill is acquired in a relatively predictable way for children who have had experiences in early childhood that fostered motivation and provided with exposure to literacy in use, attend schools that provide effective reading instruction and opportunities to practice reading. Based on this assertion, executive functions should be considered among the essential learning skills that influence young children's behaviour and consequently literacy and numeracy skill-attainment particularly in the first grades. Teachers also need to know that executive functions like any other behaviour and skill can be initiated and nurtured in young learners. The advantage is that young learners are better placed to learn new skills than their older peers.

Studies across the world have also assessed the influence of executive functions in mathematics performance. Bull, Espy, Wiebe, Sheffield, & Nelson, 2010 found that inhibitory control and working memory were positively associated with preschoolers' early math skills. In addition, Clark et al. (2013) who established that children's inhibitory control and working memory at age 3 predicted their early math achievement two years later, after controlling for their prior informal math skills, vocabulary, and processing speed.

Notwithstanding numerous curriculum innovations in the Zambian education system aimed at improving performance, many young learners still fail to acquire grade-level reading, writing as well as numeracy skills. Not long ago the language of instruction in teaching literacy was changed from English to local and familiar language, but to no meaningful improvement at all of literacy levels (Kelly, 2000). In the same vein, Matafwali (2010) further argues that there is no empirical evidence to establish the causal factors underlying the persistent reading failure among many Zambian children given the rich literacy programme in place. The concern, therefore is, if children in the foundational years fail to acquire grade-appropriate initial literacy and numeracy skills, their academic progression in consecutive schooling-years would be at a great risk. To be able to acquire literacy skills with ease, children need an all-round enabling environment in which they regulate their own behavior learning and learning.

Given this background, the present study, therefore, focused on multiple factors which included: child-characteristics, home economic and literacy circumstances and the quality of school in combination as the critical driving forces which can enhance or hinder the acquisition of grade-level literacy and numeracy. If the home and school environments are to benefit children's learning, care-givers and teachers need to cross-pollinate their views and experiences in order to establish some common ground for learner-support. Therefore, the concept of parental involvement in the education of their children is a crucial issue which the education system in Zambia needs to consider if young learners school performance has to improve. This is so because children need consistency in terms of care and handling and to give them the best of this, young school-going children need the home and school environments that prioritize their needs in general. The importance of the home literacy and school practices is grounded in the fact that the home serves as a primary setting in which language, literacy and socialization are first encountered. The school then becomes a secondary setting which is affected directly by what comes from the child's home and later influences the home. A learning cycle comes into effect implying that what happens in the home affects the child in school either positively negatively, and also what goes on in the school affects the child at home.

Some children who are raised under deprived conditions show higher levels of behavioural and health problems than their low reactive peers. Such children have been traditionally identified as particularly vulnerable to stressful experiences (Obradovic et al., 2010). In reply to family adversity and poor health, children may manifest neurobiological stress reactivity. This manifestation is also likely to affect their learning mood in school. A few researchers have challenged this traditional view, arguing that high reactivity, whether measured at the emotional, behavioral, or biological level, is not a unitary, pathogenic response to adversity that invariably leads to maladaptation. Belsky and colleagues (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007), for example, have posited that temperamentally reactive children may show higher susceptibility to environmental influences ''for better and for worse.'' Teachers need to be aware and sensitive about these issues as they can help learners benefit from the education system. It is, therefore, imperative that caregivers and teachers in all settings are knowledgeable about emergent literacy and make concerted effort to ensure that all children experience literacy rich, stress free (home and schools) environments to support their development into conventional literacy.

In this study, home literacy and home-learning support were not significant predictors of any of the five academic skills at all. These results seem to suggest that the quality of home literacy and home learning-support was poor, hence the failure to strongly predict academic achievement. The fact that data was captured through a self-report questionnaire by children's care-givers could mean that some respondents wanted to sound socially desirable thereby claiming that they rendered learner-support in their homes whose quality does not correlate with performance.

5.8 Executive functions as predictors of early literacy and numeracy skills

Among the background variables that were used in this study were executive functions. Specifically inhibition, shift, working memory, emotional control and planning and organization were predictors. Executive functions are a set of cognitive abilities that control and regulate behaviour that is required for learning. (Diamond et al, 2007). These skills cover basic cognitive processes that organize thought resources towards a desired condition and preschool and foundational years of schooling seem to be an important time for the development of executive functions. Kroesbergen et al (2009) argue that executive function is an umbrella term for different higher order functions, such as planning, inhibition, and updating, and executive functions are necessary for the adequate execution of complex goal-directed activities, such as mathematical tasks (Welsh, 2002). Executive functions are especially important in novel situations in which one cannot rely on routine and have in common the regulation of other cognitive skills.

Four analyses namely: bivariate correlations, regression analysis, t-tests and the discriminant function analysis were conducted to ascertain the role of executive functions and their association with literacy and numeracy skills at low and high performing schools. To start with, bivariate correlations was run to find if there were any associations between executive functions, literacy and numeracy. An association was observed between mathematics number-sense and working memory as well as planning and organisation. This was expected because working memory has been reported to influence the learning of mathematics which needs recall in order to solve given mathematical problems. For example, to solve a given mathematical problem, a child goes through several steps before arriving at the final answer. Mental strategies also rely heavily on planning and organization which lead to problems solving. It was also observed that on mathematics number sense, the study recorded weak and insignificant associations with the inhibition, shift and emotional control. Although it was surprising to note that mathematics number-fact did not correlate along the same pattern with executive functions as did mathematics number-sense, the understanding is that the two concepts differ in terms of what psychological skills go with them.

For the sake developing literacy and numeracy skills, children need to regulate their behaviour. Therefore, executive function skills are supposed to be stimulated in preschool and elementary grades as teachers are expected to teach activities which stimulate executive function skills such as attention, working memory and inhibition skills (Diamond et al., (2007). Blair (2010) also notes that executive function skills are associated with school readiness, turn-taking and paying attention. It is not clear, however, if the Zambian teacher education curriculum contains executive functions as topic. If teachers are not aware of these skills and how they influence behaviour of children, they would include them in routine skills which children are subjected to almost on the daily basis.

Given this background, children's performance in reading, writing and mathematics cannot be detached from executive functions stress inducing experiences. Executive functions are key to learning achievement in that they guide a learner how to plan, control and monitor their own learning. As already alluded to, these skills can be taught to learners by care-givers at home and teachers in schools who on a daily basis interact with learners.

This study hypothesized that children who went to high performing schools would be rated high on executive functions compared to those who went to low performing schools. The findings of the study on the contrary, as the findings revealed that children who went to high performing schools were generally rated poor on emotional control, working memory and planning and organization. This may also imply that teachers who taught at high performing schools were more strict with monitoring children's behaviour in the classroom and any diversion from their instructions was described in terms of poor executive functioning.

Teachers who are very strict may sometimes misjudge children who are always willing to participate in class. Such children may be described to be naughty and would be rated with low inhibition. On the part of teachers, teaching in crowded Zambian public school classrooms can be a challenge as well. Certain executive functions such as planning and organization and emotional control seem to work in favour of those outgoing children whose presence is always noticeable. Lack of planning and organization skills can lead to loss of concentration on given classroom tasks such drawing, copying and solving some sums. Because executive functions predict school readiness (Blair & Razza, 2007), later academic performance (Raver et al., 2011; Li-Grining, Raver, & Pess, 2011), and mental and physical health (Moffitt et al., 2011), if the early disparity in executive functions is narrowed, the disparity in school readiness and academic and health outcomes should be narrowed as well.

Since most children who went to high performing schools had few other children in other grades in the home, the assumption is that lack of adequate peer interaction in the home predisposed such children to poorer emotional control when they got in a school environment with many other children. From this perspective, children who fail to regulate their behaviour are likely to perform poorer in literacy and numeracy because learning usually demands concentration, recall, organization and making task linked adjustments which differs from predetermined remote instructions.

In Zambia, the school systems do not seem to emphasise executive functions as it appears to be one of the missing themes at primary teacher training level. Once children are oriented on how to regulate their own learning, it is likely that learning instructions would be easily applied by children in early and later grades.

From the present study, low and high performing schools showed significant differences between working memory and planning and organisation only. This is not different from the results of bivariate correlation results presented above were associations were noticed with the same executive function skills. Among the three executive function skills, working memory recorded the higher margin.

The results above confirm that grade 1 children in Zambian primary schools lack executive function skills orientation. This lack of self-regulatory skills would certainly have a negative telling effect on pupils performance in academic skills. It was interesting to note that even after grouping the background variables in a discriminant function analysis, working memory, planning and organization, and emotional control were the only executive functions skills which were significant. All these results confirm that Grade 1 teachers do not seem to understand and appreciate the role of executive functions and their connection learning achievement.

In this study, results on working memory indicate that children who went to high performing schools were rated by their teachers to have poor working memory while those who went to low performing schools were rated to have better working memory. A similar result pattern was found for planning and organization indicating that children who went to high performing schools were not better at planning and organization compared to those who went to low performing schools. It is possible, therefore, that low rating on executive functions was also noticeable among other correlates of mathematics performance because some cognitive skills facilitate the acquisition of certain academic skills. It is therefore expected that children who are rated high on executive functions can also be described as high achievers in literacy and numeracy.

The present study acknowledges that RSA (stress) reactivity cannot be discussed in isolation, but better in relation to other factors that induce it. As already cited, home-school connections have a lot to do with children's stress and emotion levels which later affect their performance in literacy and numeracy. Tolchinsky et al (1995) indicate that different perspectives on early literacy influence is approached in schools and they also influence the way educators make home-school connections in relation to content and process and the roles parents and caregivers can play. Some children experience a home environment that facilitates learning of literacy and numeracy skills. Other children on the contrary, come from homes where learning support is rare and sometimes inappropriate. School environments also differ as teachers are responsible to mobilize, organize and utilize school facilities in their own style. To get the best of what teachers do to learners, there is need for them to cater for the diverse needs of their learners. As a result of poor emotional control which would later lead to failure, children's stress levels would be affected as well. Therefore, in addition to other possible causal factors, the poor performance noticed in this study has a lot to do with children's poor executive functions.

5.9 Selected variables and their predictive role of RSA (stress) reactivity

In this study, RSA (stress) reactivity was used first as a background variable when it was considered together with other predictors and secondly as an outcome variable. As a background variable, it was hypothesized that RSA (stress) reactivity was associated with certain literacy and numeracy outcomes. It was also anticipated on the other hand that preschool, home possession, mathematics number fact and mathematics number sense could induce RSA (stress) reactivity among some learners. These analyses aimed at identifying potential underlying factors that may explain the cause of RSA (stress) reactivity in children. The basic assumption was two-fold. Firstly it was assumed that some negative home-circumstances such low social economic status (SES) could induce stress. On the other hand, poor performance in mathematics skills was also assumed to be a possible cause of stress reactivity.

This study revealed that children who came from homes with more siblings in the home were more reactive to challenging situations while those children who had attended preschool were less reactive than their peers who had not to preschool. According to the RSA (stress) reactivity, decreased RSA implies high reactivity while increased RSA means low reactivity. It is possible that when children have an experience of preschool, through social interactions they experience a lot of peer interactions and challenges. Even when they get to the first grade, such children are likely to benefit from challenging tasks and this would help them cope with pressure, a behaviour which is necessary for learning. For those children who came from homes with many children, it was not surprising that results showed an association with RSA (stress) reactivity because when children are too many in a home, they usually fight as they compete for the scarce resources such as play toys. Such children are likely to exhibit reactive tendencies when found themselves in crowded places like schools where competition is eminent.

It was anticipated, in both extreme situations that individual differences would heighten or suppress the RSA (stress) reactivity. Based on these assumptions, single-model regression analysis was conducted to predict RSA (stress) reactivity from the four variables which include; preschool, home possessions, mathematics number-facts and mathematics number-sense. This was necessary to do as it was expected that RSA (stress) reactivity not only can affect academic performance, but it can also be induced by certain situations either at home or at school. Among the four predictor variables, preschool emerged as the strongest followed by mathematics number-sense. Home possessions and mathematics number-sense were not strong predictors of RSA (stress) reactivity. These results suggest that the nature of learning and activities children were exposed in preschool were responsible for inducing stress in learners even after they left preschool for about one year. Although home possessions did not come out as a strong predictor like preschool, it is possible that the combined effect of preschool and home possessions induced RSA (stress) reactivity. This is so because preschool and home possessions registered a significant correlation with 27% explained variance. For mathematics number-sense it is possible that when children failed to solve some sums, their RSA (stress) reactivity levels would be triggered.

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The present study further acknowledges that the performance of learners at school cannot be viewed and addressed in isolation from either child characteristics or home environment points of view. The school is merely an environment where child and home factors combine. Classroom teachers, therefore, need to play a facilitator-roles and to do so, every teacher needs some knowledge, skills and competences to motivate and support learners to learn. Although teachers teach learners in a group, learner-support is better rendered to suit individual needs, making teaching a demanding job.

Saez (2012), for example, established that effective individualized instruction was related to higher reading scores. For this reason, teachers of young children especially, need to be professional and passionate in how they organize and conduct their teaching without which their presence in the classroom would not benefit young learners. This is important because young learners, for example those in the first grade are highly dependent on the teacher for guidance and support.

5.10 School quality as a grouping factor on background variables difference

Since the present study was based on the premise of school quality influence, means for low performing and high performing schools were compared on background and outcome variables. This measure was necessary in order to compare and contrast the influence of school quality on all variables. Significant results mean differences were noticed on the following: children in other grades, home literacy, home learning support, working memory, reading and writing, planning and organization, alphabet knowledge including reading and writing.

The present study also classified children's performance according to the same two school-groups in order to further explore the correlations among the following variables: mathematics number-sense, mathematics number-facts, reading and writing, phonemic awareness and alphabet knowledge. Discriminant function analysis is a multiple regression procedure for pooled within groups analysis. This analysis appeared to be appropriate for this analysis since all the five academic variables are continuous. Furthermore, the analysis was an adequate technique as it maximizes the differences between the two existing groups on the basis of a set of predictor variables. Compared to other prediction tests, discriminant function analysis is unique in that predictor variables can either be background or outcome variables. By carrying out a direct entry on discriminant analysis, it was easy to test at once variable prediction strength on the basis of group membership. Of the five academic skills, three on literacy and two on numeracy, interesting findings came up as the analysis aimed at testing whether school-quality membership predicted learner-performance in the five outcome variables of this study. In the present study, results indicate variability between the two school groups.

One discriminant function was found since there were only two groups (namely low performing and high performing schools). On the basis of all the five predictors, the present study revealed that there was reliable association between the low and high performing schools and the predictors (with mathematics number-sense and reading and writing) representing 50% and 31% of variance, respectively. In this analysis strength of the correlation was represented by the canonical correlation.

The discriminant function analysis showed that low performing schools were high on home learning-support. This could be so because parents from high SES took their children to high performing schools where it is anticipated that schools , always teach in the best ways possible. Secondly, learning support could also come from siblings in the home. Generally most Zambian families are large in size in terms of number of children. The presence of school-going children provides an opportunity of social interaction as well as peer learner-support, a situation which may not be the case with high performing schools.

Between the two school groups, children from high performing schools were rated high on working memory. while those children from low performing schools were rated low

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5.11 Summary

The present study has helped to substantiate connections among children susceptibility factors, self-regulatory skills, the home literacy situation, quality of instructions and ultimately grade one pupils' skill-attainment in literacy and numeracy. Child characteristics and well-being is one thing, home literacy and home learning-support is yet another factor, but both of which need a supportive and enabling school environment.

The challenges in Zambia still remain high on how children's home environments offer facilities and support that schools consider key for better academic achievements. Research has shown the role home factors such socioeconomic status, home literacy, home learning-support. A contrary view ia advanced by Kellaghan et al (1993) who are argue that the family socioeconomic status need not determine a child's achievement at school. They propose that for academic success, it is what parents do in the home, and not children's family background that is significant. Redding (1999) adds that in relation to academic outcomes, parental limitations associated with poor economic circumstances can be overcome by parents who provide stimulating and supportive and language rich experiences for their children. Other studies hold different views emphasizing that socioeconomic status is one of the strongest predictors of performance differences in children at the beginning of first grade (Raz & Bryant, 1990). Furthermore, children from low-income families are at a distinct disadvantage at the onset of school with regard to language ability (Dickinson & Snow, 1987).

Regarding school quality, the study has revealed that this variable was a strong predictor of reading and writing and mathematics number-sense only. Children who went to high performing schools performed better in reading and writing than their counterparts who went to low performing schools.

With regards to mathematics number-sense, results seem to indicate that children who went to high performing schools did not do better than those who went to low performing schools. In this case, school quality was a strong and positive predictor of reading and writing, but did not positively influence performance in mathematics number-sense. This performance could be attributed to how the literacy and numeracy curricula that are administered. Schools do not seem to balance the teaching attention to the two academic skills. Teachers at low performing school seem to teach more mathematics skills compared to their counterparts at high performing schools who seem to concentrate more on the teaching of reading and writing.

This body of research points to the fact that the attainment early literacy and numeracy skills in the first grade depends on a variety of factors and experiences within the home and the school environment. The study has also established that there exists an interplay among background variables to determine different types of academic outcomes. It is certain that most child characteristics cannot be detached from one another.. Given these connections among variables, it then difficult to discuss academic outcomes from the perspective of a single causal factor.

Reading activities within the home environment, for instance, play a crucial role in enabling a child to achieve practical efficiency in reading. Equally other factors in the home still contribute to children’s performance. School as a place where children from different home settings meeting can facilitate or inhibit learning. The study has established that even in well-organized schools, the performance of children may not be absolutely uniform as children respond differently to similar situations based on their individual potentialities.

In terms of prediction, preschool and home possessions have been associated with alphabet knowledge, and not the other academic skills. School quality was a strong predictor of reading and writing as high performing schools scored quite high on this variable. However, on the number-sense outcome, low performing schools were better, implying that instructional practices differed from one category of school to another. Such differences over-rule the general initial assumptions that all children at high performing schools would do better in all academic skills while all children attending low performing schools would do worse in all academic skills.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The goal of the this study was to find out the differential effects of child characteristics including home and school in early literacy and numeracy skill attainment in the first grade in Zambia primary schools. After examining child characteristics, home factors and school quality, the study brought out a number of interesting findings outlined below.

The study has clearly established that preschool, home literacy and home learning-support were not strong predictors of literacy and numeracy skills, except for alphabet knowledge. Children's performance in literacy and numeracy skills was generally low compared to what other studies have found regarding the predictive role of variables such as executive functions.

Among the five executive functions, working memory, emotional control and planning and organization appeared to be strong predictors in most cases. RSA (stress) reactivity was not a strong predictor although it was associated with preschool attendance, phonemic awareness and mathematics number-sense negatively.

Phonemic awareness came out as the most problematic variable which could not be significantly predicted by any background variable. This suggests a serious missing component as far as the teaching of early literacy is concerned. Since a lot studies points to phonemic awareness as one of the strongest predictors of early literacy, this research has further revealed that some of the poor reading levels being experienced in Zambia are connected to the neglect of applying phonemic awareness skills in schools.

The poor performance recorded could be attributed to the quality of teaching that goes on in schools. Quality of teaching is associated with quality of teacher training and attitudes. Family functioning in terms of home learning support and socio economic status had some influence as well.

Teachers and parents should collaborate regularly in order to share their concerns and experiences. Both children's homes and schools need to be centres of stimulated learning meant to improve the learning and living environments of children. This would provide learners with maximum support in terms of social and academic skill development.

Low and high performing schools had different strengths and weaknesses in terms of their influence on literacy and numeracy performance. High performing schools performed better on reading and writing and mathematics number sense, while low performing schools performed better on mathematics number-facts.

6.2 Recommendations

Based on the findings of the study, the following recommendations are made:

(i) Government through the Ministry of Education should strengthen stakeholder-collaboration between parents/care-givers of young learners and teachers in schools so to establish a clear common ground for an effective learner-support system meant to enhance early literacy and numeracy skill attainment.

(ii) To ameliorate lapses in teacher-training and orientation which has a direct effect on the teaching and learning of early literacy, the Ministry of Education, should comprehensively review the Literacy and Language Education teacher-training curriculum, methods and facilities so as to improve skill and competence levels of pre-service and in-service graduate-teachers.

(iii) In order to help teachers fully understand the importance of regulatory skills and how these facilitate social and cognitive development in young children, the Ministry of Education, Science, Vocational Training and Early Education should explicitly incorporate executive functions as one of the key topics in Educational Psychology for teacher-training.

(iv) In order to categorize schools as either low and high performing schools, the Ministry of Education should devise a school rating index which would help researchers to differentiate the two school quality groups. This would help monitor school performance more efficiently.

Implications for research

The study has shown that low and high performing schools have their own strengths and weaknesses pointing to children's literacy and numeracy skill-attainment. In this view, the quality of knowledge, skills and competences student-teachers acquire in the college of education is relative to their contribution in class at school. There is need, therefore, for the Ministry of Education and researchers in Educational Psychology to give equal attention to early literacy and numeracy research and innovations in order to render all-round academic skill-development. More studies need to be conducted on classroom activities in order to fully evaluate how teachers teach literacy and numeracy skills to young children.

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APPENDICES

Appendix 1: Biographical data

BIOGRAPHICAL DATA

DISTRICT:______________________ SCHOOL:_______________________

NAME:__________________________________ CHILD'S ID:______________

AGE:_________ DATE OF BIRTH: __________________ GENDER: _______

CLASS:________ DATE:______________________

This instrument will be completed by the researcher who will interview one pupil at a time while other pupils will be kept away from the interview room. Bemba will be used to get information from the pupils, but where necessary

SECTION 1: LANGUAGE BACKGROUND
Ask the child who looks after him/her
Say: Nibani bakusunga pangánda?
Probe further so as to ask certain questions appropriately. Some children may not be staying with their biological parents.

	LANGUAGE	**ENGLISH (1)**	**BEMBA (2)**	**OTHERS-SPECIFY (3)**
Q.1	Which language does your mother/caregiver speak best? **Citundu nshi banoko balanda sana?** (ask this question to suit the child's care-giver circumstances)			
Q.2	Which language does your father/caregiver speak best? **Citundu nshi bawiso balanda sana?** (ask this question to suit the child's care-giver circumstances)			
Q.3	Which language is used most frequently?			

	Citundu nshi ulanda inshita ishingi?			
Q.4	Which language(s) do you use when playing with others? Which language do you mostly use? **Citundu nshi mulanda ngamuleyangala nabanobe?**			
Q.5	Which language do you mainly use in class? **Citundu nshi ulanda mu class iliingi line?**			

Note: More than one option can be chosen from above.

SECTION 2: EXPOSURE TO LITERACY ACTIVITIES AT HOME

Q.1 Do you read at home?
Bushe ulabelenga ututabo ku ngánda? **1.Yes [ ]** **0. No [ ]**

Note: if the answer the above is, **No**, go to **Section 3.**

Q.2 If the response to the question above is yes, ask the child to list titles of books/journals/other reading materials he/she has read.
Ngaulabelenga kung'nda, kuti wanjebako ututabo uto ubelenga?

a) ____

b) Does someone help you when you are reading at home?
Bushe kwaliba abakwafwako ukubelenge ku ngánda? **1. Yes [ ]** **0 .No [ ]**

Q.3 If so, who?
Ngacakutila balakwafwako, nibani?
[Mother] [Father] [Siblings] [Other], please specify________________

SECTION 3: SOCIO-ECONOMIC STATUS

Q.1 What is your Father's/ caregiver's occupation?..

Nincito nshi bawiso babomba ?..
(ask this question carefully to suit the child's care-giver circumstances)

Q.2 What is your Mother's occupation?...

Nincito nshi banoko babomba?...
(ask this question to suit the child's care-giver circumstances)

Q.3 Did you attend pre-school/nursery school before coming to this school?
Bushe walisambilileko ku nursery ilyo taulatampa isukulu? **1. Yes [ ]** **0 .No [ ]**

Q.4 If the answer to the above is yes, ask the child to state the name of the school he/she went to.
Ngacakuti walisambiliileko ku nursery, lumbulula ishina lya nursery/pre-school waileko?..

SECTION 4: HOME POSSESSIONS

Q.1 Do you have a television set in your home?

Bushe mwalikwata TV pa ngánda? 1. Yes [ ] 0. No [ ]

Q.2 Do you have a radio in your home?

Bushe mwalikwata icilimba cakumfwako ilyashi pa ngánda? 1. Yes [ ] 0. No [ ]

Q.3 Do you have a stove at home?

Bushe mwalikwata icitofu pa ngánda? 1. Yes [ ] 0. No [ ]

Q.4 Do you have electricity at home?

Bushe mwalikwata amalaiti pa ngánda? 1. Yes [ ] 0. No [ ]

Q.5 Do you have running water at home?

Bushe mwalikwata amenshi yakupompi pa ngánda? 1. Yes [ ] 0 .No [ ]

Q.6 Do you have a flushable toilet?

Bushe mwalikwata icimbusu cakukumpa pa ngánda? 1. Yes [ ] 0. No [ ]

Q.7 Do you have a car at home?

Bushe mwalikwata motoka pa ngánda? 1. Yes [ ] 0. No [ ]

Q.8 Do you have at least two pairs of clothes?

Bushe walikwata ifyakufwala ifyo ucinja? 1. Yes [ ] 0. No [ ]

Q.9 Do you have at least one pair of shoes?

Bushe walikwata insapato? 1. Yes [ ] 0. No [ ]

Q.10 Do you have a bed with a mattress to sleep on?

Bushe ulala pali bed na matress? 1. Yes [ ] 0. No [ ]

Q.11 Do you live in a house with cement or tile floors?

Bushe wikala mu nganda iya kwata sementi nangu ama tiles? 1. Yes [ ] 0. No [ ]

Q.12 In which residential area do you live?

Bushe nincende nangu compound wikalako?__________________________

End.

Natatole pa kwasuka ifipusho ifi. Pali iino nshita kuti wabwelela mu class.

Appendix 2: Informed consent form for parents or guardians

THE UNIVERISTY OF ZAMBIA
SCHOOL OF EDUCATION
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY, SOCIOLOGY AND SPECIAL EDUCATION

INFORMED CONSENT FORM FOR PARENTS OR GUARDIANS

PLEASE READ THIS DOCUMENT CAREFULLY. SIGN YOUR NAME BELOW ONLY IF YOU AGREE THAT YOUR CHILD SHOULD PARTICIPATE IN THIS RESAERCH AND IF YOU FULLY UNDERSTAND YOUR CHILD'S RIGHTS. YOUR SIGNATURE IS REQUIRED FOR YOUR CHILD'S PARTICIPATION. FOR YOU TO SIGN ON THIS FORM, YOU MUST BE A PARENT OR A LEGAL GUARDIAN OF A GRADE 1 PUPIL WHO IS TO PARTICIPATE IN THIS STUDY. IF YOU DESIRE A COPY OF THIS CONSENT FORM, YOU MAY REQUEST ONE AND WE WILL BE VERY HAPPY TO PROVIDE IT.

Dear Parent(s)/Guardian(s),

My name is Ebby Mubanga, a PhD student from the University of Zambia currently doing research.

Description of the Study

Your child is being invited to participate in this study on the **Differential Effects of Child-characteristics in Literacy and Numeracy Skill-attainment at Low and High Performing Basic Schools in Northern Province of Zambia**. The aim of this study is to explain why some Zambian schools are unsuccessful in promoting beginning literacy and numeracy skills. The study will also attempt to suggest appropriate corrective interventions to improve the prevailing low literacy and numeracy skill-levels among young learners in grade one.

Safety of the study

We wish to assure you that, during and after children's tasks, this study does not pose any physical, mental or other risks to your child. The nature of the tasks is that your child will be required to do certain age-appropriate speaking, reading, writing and arithmetic tasks. Prior to that, we will measure your child's heart rate. Then we will proceed with other tasks. This, therefore, requires your consent which is a very important step in this study.

The small device to be used in heart-rate measurement uses stickers which will be placed on three front areas of the body (part of the chest and belly). The heart-rate measurement will take place when the child will be engaged in some age-appropriate tasks such as answering some questions, watching two video clips and a sensory taste. Heart measurement will be for a period of 20 minutes per child.

Time Involvement:
Some time may be lost from your work schedule as it is necessary that you are fully explained to how this study will be conducted. In addition, there is a questionnaire for you to which are expected to respond. This is very important as well because we need to get information from you the parent/guardian regarding the home situation in connection to home literacy. Secondly, your child will also be withdrawn from class for a couple of minutes when being assessed and later they will return to class. It should be mentioned that children’s assessment will not be completed on a single day because the different activities meant for children cannot be concluded on the same day. An arrangement will be made at school on how best these activities will be conducted.

Activities for Teacher

The class teacher will be requested to answer some statements on each child away from the children. This will be done during the teacher’s spare time. This information is also very important in order to get the teacher’s experiences and explanation of your child’s behaviour in class.

Activities for Children

Responding to a questionnaire and attending assessment tests in reading, writing, speaking and arithmetic.

Foreseeable Benefits:

We cannot guarantee that you and your child will receive any direct benefits from this study. However, as a parent/guardian, you will have an opportunity to contribute to the improvement of education for young learners, a contribution that will benefit this nation a great deal. You will also learn one or two other things about your children’s education which educationists and researchers are interested in.

Compensation for Your Time:
You will receive Twenty Kwacha (K20=00) cash just for your transport. At one point, your child will also be give exercise books, a pencil and a rubber just as token of appreciation for their participation in this study.

Participant Rights:

- Participation in this study is purely voluntary so if you decide to withdraw your child or yourself at any point, you may freely do so, and there will be no consequences for that decision. However, we are very interested in working with you.
- All personal identifying information about you and your child will be kept confidential and the data sheets will be kept in secured lockers in accordance with the standards of the University of Zambia Research and Ethics Committee. If the results of this study are required for publication as we hope to do, your identity will still be kept very private. This is the standard way of conducting this type of research.
- Feel free to ask any question so that you fully understand this whole important activity.

Signatures:

I,…………………………………………………………......(father/mother/legal-guardian) to ………………………………(name of Grade1 child) have read and understood the above information. My signature testifies that I understand the nature of this study, consent process and management of confidentiality as indicated above. I also understand that I can withdraw my child and myself at any time during this study.

Signature of participant's parent:…………………………………………

Phone Number:……………………………………………………………

Date……………………...

Name of Witness:…………………………………………………………

Signature of Witness:……………………………………………………..

Phone Number:……………………………………………………………

Date…………………………………………………………………….

Name of Researcher:………………………………………………………

Signature of Researcher:…………………………………………………

Phone Number:……………………………………………………………….

Date……………………………………………………………………….

Contacts

For further clarifications about this research, please you may contact the following people, the first three who are my supervisors in this research.

Professor Adriana, G. Bus
Leiden University
Social and Behavioural Sciences
Department of Child and Family Studies
P.O. Box 9555,2300 RB Leiden
The Netherlands

Dr. Sophie Kasonde-Ng'andu
Assistant Dean Postgraduate
School of Education
University of Zambia
P.O. Box 32379
Lusaka

Dr. Beatrice Matafwali
Head of Department,
Department of Educational Psychology, Sociology and Special Education
School of Education
University of Zambia
P.O. Box 32379
Lusaka

The Administrative Secretary
Humanities and Education Research and Ethics Committee
Great East Road Campus
University of Zambia
P.O. Box 32379
Lusaka

Appendix 3: Informed consent form teachers

THE UNIVERISTY OF ZAMBIA
SCHOOL OF EDUCATION
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY, SOCIOLOGY AND SPECIAL EDUCATION

INFORMED CONSENT FORM TEACHERS

PLEASE READ THIS DOCUMENT CAREFULLY. SIGN YOUR NAME BELOW ONLY IF YOU AGREE THAT YOU FULLY UNDERSTAND YOUR RIGHTS. YOUR SIGNATURE IS REQUIRED FOR YOUR PARTICIPATION. FOR YOU TO PARTICIPATE IN THIS PROJECT, YOU MUST BE A TEACHER WHO KNOWS THE CHILDREN FAIRLY WELL. IF YOU DESIRE A COPY OF THIS CONSENT FORM, YOU MAY REQUEST ONE AND WE WILL BE VERY HAPPY TO PROVIDE IT.

Dear Sir/Madam,
My name is Ebby Mubanga, a PhD student from the University of Zambia currently doing research.

Description of the Study:
You are being invited to take part in this study on the **Differential Effects of Child-characteristics in Literacy and Numeracy Skill-attainment at Low and High Performing Basic Schools in Northern Province of Zambia**. The aim of this study is mainly to explain why some Zambian schools are unsuccessful in promoting beginning literacy and numeracy skills. The study will also attempt to suggest appropriate corrective interventions regarding the prevailing low literacy and numeracy skill-levels among young learners in grade one.
You will be required to respond to certain statements pertaining to the child behaviour in your class.

Safety of the study
We wish to assure you that this study does not pose any physical, mental or other risks to you. At certain intervals, children will do some speaking, reading, writing and arithmetic tasks. Prior to the administration of those tasks, heart-rate will be measured. The small device to be used in heart-rate measurement uses stickers which will be placed on three areas of the body. Heart-rate measurement will be done when children will be doing some tasks for 20 minutes per child.

Time Involvement:
Time will be lost from your work schedule as it is necessary that you are explained to how this study will be conducted. This is very important. You will do this study alone away from the pupil and during your spare time. On one of the days, your class sessions will be requested to be observed.

Teachers' task

As a class teacher, you will be required to complete a questionnaire about each child's behaviour in class.

Activities for Children

Responding to a questionnaire and attending assessment tests in speaking, reading, writing and arithmetic.

Foreseeable Benefits:

We cannot guarantee that you will receive any direct benefits from this study. However, as a practising teacher, you will have an opportunity to contribute to the improvement of education for young learners that will benefit this nation a great deal. In addition to your knowledge as a teacher, you will certainly learn one or two other things about children's education which other educationists and researchers are interested in.

Compensation for Your Time:

You will receive Fifty Kwacha (K50:00) cash. At one point, each participating child will also be give exercise books, a pencil and a rubber just as token of appreciation for their participation in this study.

Participant Rights:

- Participation in this study is purely voluntary so if you decide to withdraw at any point, you may freely do so, and there will be no consequences for that decision. However, we are very much interested in working with you.
- All personal identifying information about you and the participating children will be kept confidential and the data sheets will be kept in secured lockers in accordance with the standards of the University of Zambia Research and Ethics Committee. If the results of this study are required for publication as we hope, your identity will still be kept very private. This is the standard way of conducting this type of research.
- Feel to ask any question so that you fully understand this whole activity.

Signatures:

I,………………………………………………………(name of participant-teacher) having read what this study is all about do hereby agree to participate. My signature testifies that I understand the nature of this study, consent process and management of confidentiality as indicated above. I also understand that I can withdraw at any time during this study.

Signature of Research Participant:……………………………………………

Phone Number:…………………………………………………………………

Date……………………..

Name of Researcher:………………………………………………………

Signature of Researcher:…………………………………………………

Phone Number:……………………………………………………………

Date………………………………………………………………………..

Contacts:
For additional clarifications about this research, please you may contact the following people, the first three who are my supervisors in this research.

Professor Adriana, G. Bus
Leiden University
Social and Behavioural Sciences
Department of Child and Family Studies
P.O. Box 9555
2300 RB Leiden
The Netherlands

Dr. Sophie Kasonde-Ng'andu
Assistant Dean Postgraduate
School of Education
University of Zambia
P.O. Box 32379
Lusaka

Dr. Beatrice Matafwali,
Head of Department,
Department of Educational Psychology, Sociology and Special Education
School of Education
University of Zambia
P.O. Box 32379
Lusaka

Administrative Secretary
Humanities and Education Research and Ethics Committee
Great East Road Campus
University of Zambia
P.O. Box 32379
Lusaka

Appendix 4: Family Literacy Questionnaire

FAMILY LITERACY QUESTIONNAIRE (FLQ)

Child's Parent/Guardian Demographic Data

Name of child being represented: ………………………………………………….

Sex of child : 1 Girl [ ] 2. Boy [ ]

Age of parent/guardian: …………………………. Sex: 1. Female [ ] 2. Male [ ]

Relationship to the child: 1 Biological [ ] 2. Other [ ]

Child ID #: ………………………….

Answer the following questions by ticking or writing in the spaces provided. Understand each item carefully before to respond to it.

1. How many children of school going age are in your home? ……………….
   (b) Of these, how many are in the…

1. First grade?	
2. Second grade?	
3. Other grades?	

2. What is your highest level of education? (tick only one)

1.Never been to school	
2.Primary: grade 1 to7	
3.Junior secondary: grade 8 to 9	
4.Senior secondary: grade10 to 12,	
5.Post secondary 2-3 years training	
6.Bachelor's degree	
7.Masters degree and above	

3. What do you do mainly to earn your living? (tick just one)

1.Government or company employed		specify
2.Self-employed or big business person		specify
3.Small business person		specify:
4.Neither employed nor in business		specify

4.Are you able to read and write?

1. Very well	
2. Fairly well	
3. A bit	
4. Not all	

5.Do you have a general family library in your home? (tick only one)
1.Yes [ ] 0. No [ ]

6. Do you have a specific library for young children in your home? (tick only one)
1. Yes [ ] 0. No [ ]
If no, justify your answer:

7. Approximately or exactly how many story books for children are there at your home? …………

8. Do you get children's story books from schools? 1. Yes [ ] 0. No [ ]

9. Do you get children's story books from shops? 1. Yes [ ] 0. No [ ]

10. Do you get children's story books from libraries? 1. Yes [ ] 0. No [ ]

11. Do you select books for children yourself? 1. Yes [ ] 0. No [ ]

12. Do experts such as teachers select books for your children? 1. Yes [ ] 0. No [ ]

13. Does your child select books for him/herself? 1. Yes [ ] 0. No [ ]

14. If there is a children's library, can you remember some of the book-titles found in this library? (tick only one). 1. Yes [ ] 0. No [ ]

15. Do you read to your child/ren in your home? (tick only one)

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

16. Did you last read to your child in the last seven days? 1. Yes [ ] 0. No [ ]

17. Do you have a schedule/timetable to guide your reading sessions with your child/ren? 1.Yes [ ] 0. No [ ]

18. Do you engage your child to practice reading letters of the alphabet? 1. Yes [ ] 0. No [ ]

19. Do you engage your child to practice reading syllables (e.g ba be bi bo bu)?
1. Yes [ ] 0. No [ ]

20. Do you engage your child to practice reading words in Icibemba? 1. Yes [ ] 0. No [ ]

21. Do you engage your child to practice reading sentences in Icibemba? 1. Yes [ ] 0. No [ ]

22. Do you engage your child to practice reading stories in Icibemba? 1. Yes [ ] 0. No [ ]

23. Do you experience any challenges when reading to your child/ren?

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

24. Do you engage your child to practice writing letters of the alphabet? 1. Yes [ ] 0. No [ ]

25. Do you engage your child to practice writing syllables (e.g ba be bi bo bu)? 1. Yes [ ] 0. No [ ]

26. Do you engage your child to practice writing words in Icibemba? 1. Yes [ ] 0. No [ ]

27. Do you engage your child to practice writing sentences in Icibemba? 1. Yes [ ] 0. No [ ]

28. Do you engage your child to practice writing stories in Icibemba? 1. Yes [ ] 0. No [ ]

29. Do you experience any challenges as you engage your child in writing activities?
(tick only one)

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

30. Do you engage your child to practice counting with sticks/stones/etc? 1. Yes [ ] 0. No [ ]

31. Do you engage your child to practice counting orally? 1. Yes [ ] 0. No [ ]

32. Do you engage your child to practice Maths through songs? 1. Yes [ ] 0. No [ ]

33. Do you engage your child to practice Maths by writing numbers? 1. Yes [ ] 0. No [ ]

34. Do you engage your child to practice Maths by solving simple sums? 1. Yes [ ] 0. No [ ]

35. Do you engage your child to practice Maths by playing games? 1. Yes [ ] 0. No [ ]

36. Do you engage your child to practice Maths by playing puzzles? 1. Yes [ ] 0. No [ ]

37. . Do you experience any challenges in Maths with your child/ren?
(tick only one)

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

38. Does your child get any assistance with school work at home? 1. Yes [ ] 0. No [ ]

Do you give verbal praises to your child when he/she does well with school work? 1. Yes [ ] 0. No [ ]

39. Do you buy tokens/presents for your child when he/she does well with school work? 1. Yes [ ] 0. No [ ]

40. Do you share your observations regarding your child's performance at home with your child's class teacher? (tick only one)

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

41. Do you receive information regarding your child's performance at school the child's class teacher? (tick only one)

2. Usually [ ] 1. Sometimes [ ] 0. Never [ ]

END

Thank you very much for taking your time to participate in this study.

Appendix 5: Basic Skills Assessment Tool (BASAT)

BASIC SKILLS ASSESSMENT TOOL (BASAT Revised)

Reading and Writing - Grade 1

Pupil's name:____

School:_______________________

	Year	Month	Date
Date of assessment			

Class:_______________________

Class teacher : ___________________________ Sex: ____________

Assessor/ Researcher: ______________________________________

Province:___________________ District: ______________________

Sex of child : boy ☐ girl ☐

Start time: _________ End time: __________

1. Does the child have any disabilty? (Please tick where necessary)	
a. Physical Impairment	
b. Visual Impairment	
c. Hearing Impairment	
d. Intellectual Disability	
e. Speech/ Language Impairment	

2.Child's Language and behaviour skills	Yes
1. Speaks well	
2. Use age-appropriate language	
3. Pays attention when being spoken to	
4. Narrates stories well	

5. Remembers names of people and common items	
6. Plays wells with friends	
7. Carries out assigned tasks at school	
8. Carries out assigned tasks without supervision	
9. Likes working with friends	
10. Likes going to school	
11. Has generally good health	
12. Generally socially alert	
13. Holds a pencil well and buttons up shirt well	

3. Summary of tasks	
Part	**Comments**
A. Letter-knowledge	
B. Letter-sound knowledge	
C. Syllable segmentation	
D. Reading	
E. Writing	
F. Digit span	
G. Reading comprehension	

A. Ukwishiba ifilembo (Letter knowledge)	**Child knows**	**Child does not know**
1. Lumbula ifilembo fya alphabet ukufuma pali ifyo nakulasonta) **(Name letters of the alphabet)**		
2. Sonta ifilembo fya alphabet		

ifyonakulumbula **(Identify letters of the alphabet by pointing to each)**		
B. Ukwishiba ifiunda fya filembo (Letter-sound knowledge)	**Child knows**	**Child does know**
1. Lumbula ifiunda ifipangwa nefi filembo **(Letter-sound identification)**		
2. Sonta ifilembo ifipanga ifiunda ifyonkulalanda **(Sound -letter identification)**		

C. Imilimo yapafiunda	**Child knows**	**Child does know**
1. Lumbula ifiunda fyakulekeleshako mumashiwi aya umo yakonkanine. (Ending syllable discrimination) Example: moto**ka**		
(a) maa**yo**		
(b) Iko**ti**		
(c) imfu**la**		
(d) bule**ti**		
(e) Icii**bi**		
(f) ibuu**ku**		
(g) ama**le**		
(h) abe**ngi**		
(i) fita**tu**		
(j) ubwa**li**		
2. *Lumbula ifiunda fyapakati mu mashiwi* aya umo yakonkanine. (middle syllable discrimination in common words) **Example:** mo**to**ka		
(a) pa**tu**la		
(b) ka**la**ta		
(c) fu**ta**tu		
(d) mo**to**ka		

(e) fi**bi**li		
(f) ka**la**ta		
(g) ka**ni**ka		
(h) lo**le**sha		
(h) be**le**nga		
(i) bu**tu**ka		
(j) su**mi**na		

D. Ukubelenga (Reading)	**Child knows**	**Child does not know**
1. Belenga ili ishiwi (reading own name)		
2. Bika ifilembo fibili pamo pakupanga iciputulwa ceshiwi nangu ishiwi. ***(Making/Writing syllables)****(these are nonsense words)*		
(a) y + a=**ya**		
(c) p + a=**pa**		
(b) w + a=**wa**		
(d) c + e=**ce**		
(e) p + o=**po**		
(f) t + e = **te**		
(g) s + u =**su**		
(h) l + e =**le**		
(i) f + a =**fa**		
(j) m + i =**mi**		
TOTAL NUMBER OF SYLLABLES		
3. *Belenga amashiwi aya: (Reading one-syllable word*)		
(a) **lya**		
(b) **tii**		

(c) **nwa**		
(d) **swa**		
(e) **yaa**		
TOTAL NUMBER OF ONE-SYLLABLE WORDS		
4. Belenga amashiwi aya: (Reading two-syllable words)		
(a) **maama**		
(b) **maayo**		
(c) **yaama**		
(d) **mwana**		
(e) **taata**		
TOTAL NUMBER OF TWO-SYLLABLE WORDS		
5. Belenga amashiwi aya: (Reading three-syllable words)		
(a) ukulu		
(b) inkoko		
(c) ipika		
(d) talala		
(e) isaaka		
(f) motoka		
(g) ifipe		
(h) ibuuku		
(i) fumapo		
(j) sumina		
TOTAL NUMBER OF THREE-SYLLABLE WORDS		

E. UKULEMBA (WRITING)	**Child knows**	**Child does not know**
1. Lemba ishina lyobe **(writing own name)**		
2. Lemba ifilembo fya alphabet ifi: **(Writing dictated letters of the alphabet)**		

TOTAL NUMBER OF ALPHABET LETTERS		
3. Lemba amashiwi aya: (writing dictated two-letter syllables: nonsense words)		
(a) ba		
(b) mu		
(c) ko		
(d) pe		
(e) fi		
(f) se		
(g) to		
(h) la		
(i) mu		
(j) ni		
TOTAL NUMBER OF TWO-LETTER SYLLABLES		
4. Lemba amashiwi aya: (writing three-letter syllables)(*nonsense words)*		
(a) mwa		
(b) nda		
(c) sha		
(d) nga		
(e) lwa		
(f) swa		
(g) mba		
(h) nwa		
(i) kwa		
(j) fya		
TOTAL NUMBER OF THREE-LETTER SYLLABLES		
5. Lemba amashiwi aya: (writing words with three or four syllables)		
(a) buleti		
(b) amani		

(c) kalata		
(d) butuka		
(e) akoni		

Appendix 6: ALPHABET TEMPLATE

a	m	d	o	s
e	z	t	i	c
	u	f	p	w
g	v	n	h	l
	b	y	k	j
q	r	x		

Appendix 7 Mathematics Assessment Battery

- Cardinality
- Counting from 1 to 20
- Counting principles
- Number knowledge
- Number knowledge; number-flash
- Conservation
- Nonverbal addition and subtraction
- Addition and subtraction within a story context
- Addition and subtraction sums
- Estimation
- Number line task
- DLE-Test Mental Arithmetic

General comments

- Only use checker pieces of a different color when this is explicitly mentioned in the exercise!
- Checker pieces you're not using need to be out sight of the child
- **Only give feedback like: *you're doing great*.** Never mention whether the child made an error or not.
- The experimenter sits opposite of the child

Materials

- Five cards with 7, 5, 9, 13 and 11 stars respectively
- Box with checker pieces (20 white and 20 black ones)

- Kalulu Hand puppet
- 5 cards with dots
- Number line forms for numbers 0-100 (24 per person)
- DLE-test Mental Arithmetic exercise sheet

CARDINALITY (items 1 to 5)

Instruction

Item 1

The experimenter shows the card with the 5 stars and says: *you may count the stars. Point to them when counting, and count aloud.* When the stars are counted, the experimenter turns the card (the child is now unable to see the stars) and asks: *how many stars are on the other side of this card?*

When the child is unable to count the stars correctly, the experimenter says: *we will count them together.* Point to the stars when counting aloud, and turn down the card when all the stars are counted and ask: *how many stars are on the other side of this card?*

After responding, say something like: *good job, we will do another one.*

Item 2

The experimenter shows the card with the 7 stars and says: *you may count the stars. Point to them when counting, and count aloud.* Continue as described by item 1.

The experimenter shows the card with the 5 stars and says: *you may count the stars. Point to them when counting, and count aloud.* When the stars are counted, the experimenter turns the card (the child is now unable to see the stars) and asks: *how many stars are on the other side of this card?*

When the child is unable to count the stars correctly, the experimenter says: *we will count them together.* Point to the stars when counting aloud, and turn down the card when all the stars are counted and ask: *how many stars are on the other side of this card?*

After responding, say something like: *good job, we will do another one.*

Item 3

The experimenter shows the card with the 9 stars and says: *you may count the stars. Point to them when counting, and count aloud.* When the stars are counted, the experimenter turns the card (the child is now unable to see the stars) and asks: *how many stars are on the other side of this card?*

When the child is unable to count the stars correctly, the experimenter says: *we will count them together.* Point to the stars when counting aloud, and turn down the card when all the stars are counted and ask: *how many stars are on the other side of this card?*

After responding, say something like: *good job, we will do another one.*

Item 4

The experimenter shows the card with the 13 stars and says: *you may count the stars. Point to them when counting, and count aloud.* When the stars are counted, the experimenter turns the card (the child is now unable to see the stars) and asks: *how many stars are on the other side of this card?*

When the child is unable to count the stars correctly, the experimenter says: *we will count them together.* Point to the stars when counting aloud, and turn down the card when all the stars are counted and ask: *how many stars are on the other side of this card?*

After responding, say something like: *good job, we will do another one.*

Item 5

The experimenter shows the card with the 11 stars and says: *you may count the stars. Point to them when counting, and count aloud.* When the stars are counted, the experimenter turns the card (the child is now unable to see the stars) and asks: *how many stars are on the other side of this card?*

When the child is unable to count the stars correctly, the experimenter says: *we will count them together.* Point to the stars when counting aloud, and turn down the card when all the stars are counted and ask: *how many stars are on the other side of this card?*

After responding, say something like: *good job, we will do another one.*

COUNTING FROM 1 upto 20

Item 6

The experimenter says: *you may from 1 up to 20, ok? Let's start.* A child may start once again when making a mistake (e.g., counting 1, 2, 4…20). Encourage a child when he/she is hesitating: *Just count as far as you can.*

COUNTING PRINCIPLES: ONE-TO-ONE CORRESPONDENCE, ORDER IRRELEVANT, ABSTRACTION (ITEMS 7-14)

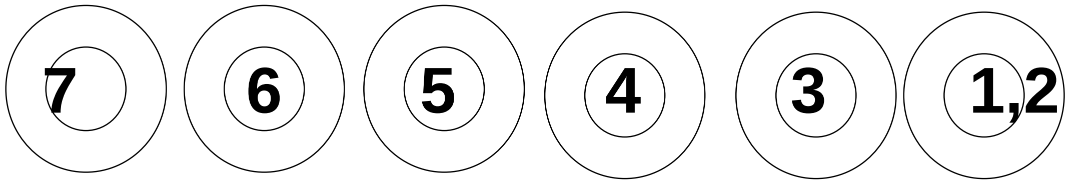
The experimenter says: *look who's here, Kalulu. Kalulu is learning to count, but sometimes makes errors. In a minute, Kalulu will start counting and you may tell whether he counted correct or not. Okay? Let's start.*

After each item, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

Remark: The figures below show how the experimenter needs to count from the perspective of the experimenter. The experimenter counts with the handpuppet, thus in fact Kalulu is counting! Always point to the checker pieces (stones) when counting!

Item 7 (one-to-one correspondence: counting from left to right →incorrect)

The experimenter puts 6 stones (of the same color) on a row and counts the stones from left to right. Recall that Kalulu is the one counting! The first stone is counted twice (see picture below).

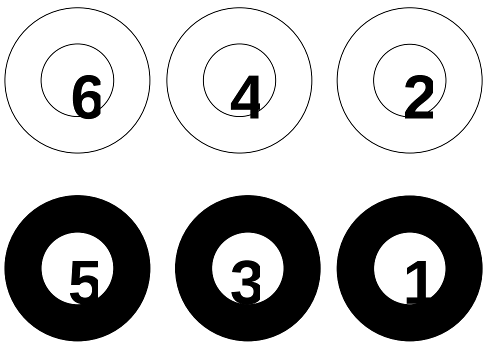


After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it*, *you may count the stones as well.* Be sure the child counts aloud.

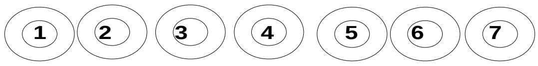
Item 8 (items of different colors are counted, abstraction: pseudo-error)

The experimenter puts two rows of three stones on the table (a white row and a black row) and Kalulu counts as specified in the picture below.

After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it*, *you may count the stones as well.* Be sure the child counts aloud.



Item 9 (one-to-one correspondence, order irrelevant: counting from right to left →correct). The experimenter puts 7 stones of the same color on the table as specified in the picture below. Kalulu

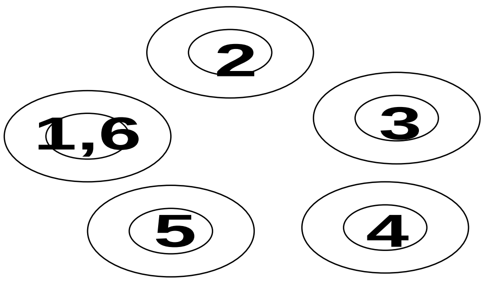


counts the stones from right to left.

After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

Item 10 (one-to-one correspondence: counting clockwise →incorrect)

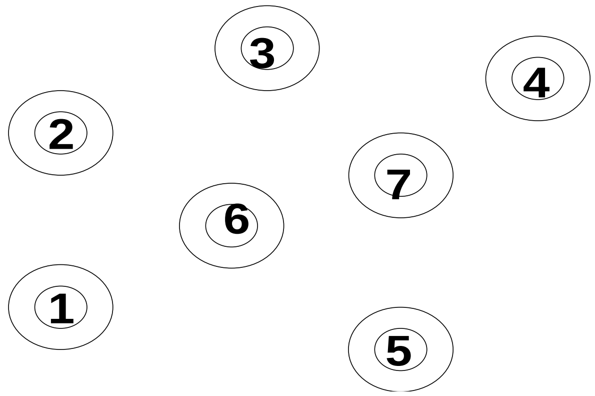
The experimenter puts 5 stones of the same color on the table (see picture below) and Kalulu counts as specified in the picture. Notice that de first stone is counted dubbel.



After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

Item 11(one-one correspondence: counting unarranged stones → correct)

The experimenter puts 7 stones on the table, unarranged (see picture). Kalulu counts the stones as specified below and puts every stone direct aside. After counting, all stones are piled.



After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud. You don't need to re-order the stones!

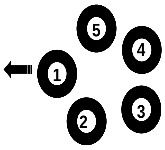
Item 12 (stones of different colors are counted separately, abstraction: pseudocorrect)

The experimenter puts two rows consisting of two stones on the table (see picture). Kalulu will first count the white stones and then de black ones (as described below). Thus when counting the black ones, he doesn't continue counting, but starts again.

After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

Item 13 (one-to-one correspondence: counting in a circle →correct)

Put 5 stones of the same color on the table as specified in the picture below.



Kalulu counts the stones as specified above and points to them. The first stone is moved to the left when counting 1.

After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

Item 14 (one to one correspondence, order irrelevant: pseudo correct)

Put 8 stones of the same color on the table (see picture below). Kalulu counts the stones as specified in the picture.

After counting, the experimenter says: *Did Kalulu count correctly?* When the child has responded, the experimenter says: *show it, you may count the stones as well.* Be sure the child counts aloud.

NUMBER KNOWLEDGE (ITEM 12-15)

The experimenter says: *Kalulu has become tired from counting and will go to sleep* (put Kalulu aside). *We are going to do another game.*

Item 15

The experimenter asks the child: ***which number comes after 7?***

Item 16

I say two number, you may say ***which one is bigger. 9*** **(short break)** ***2***. *Which number is bigger?*

Item 17

We'll do another one. ***Which number precedes 5****?*

Item 18

I will say two numbers, ***which one is smaller? 4*** **(short break)** ***3***. *Which number is smaller?*

CONSERVATION PRINCIPLE

The experimenter gets the checker pieces.

Item 19

Put 4 stones of the same color in a row and say: *you may count these stones. Please count aloud.* The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together.* Count the stones and point to them when counting.

Next, the experimenter says: *look carefully.* Split the row in two parts of two stones and ask: *how many stones are here together?* (the experimenter circles around both pairs of stones at once).

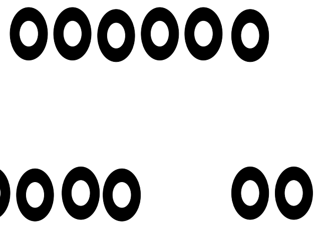
OOOO

OO OO

Item 20

Put 6 stones of the same color in a row and say: *you may count these stones. Please count aloud.* The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together.* Count the stones and point to them when counting.

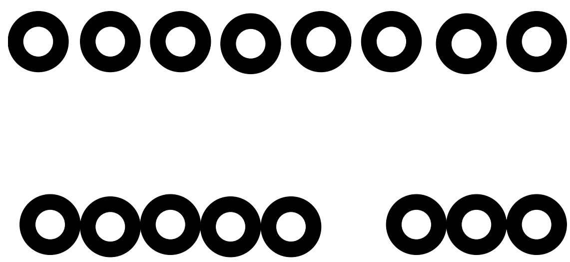
Next, the experimenter says: *look carefully.* Split the row in two parts of 4 and 2 stones respectively and ask: *how many stones are here together?* (the experimenter circles around both pairs of stones at once).



Item 21

Put 8 stones of the same color in a row and say: *you may count these stones. Please count aloud.* The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together.* Count the stones and point to them when counting.

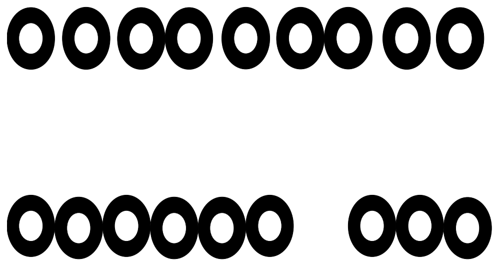
Next, the experimenter says: *look carefully.* Split the row in two parts of 5 and 3 stones respectively and ask: *how many stones are here together?* (the experimenter circles around both pairs of stones at once).



Item 22

Put 9 stones of the same color in a row and say: *you may count these stones. Please count aloud.* The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together.* Count the stones and point to them when counting.

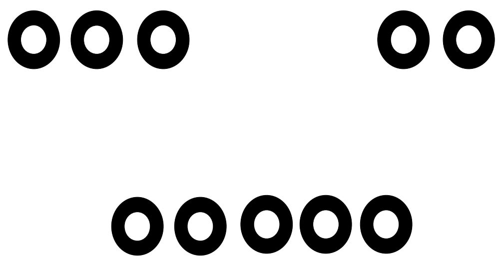
Next, the experimenter says: *look carefully.* Split the row in two parts of 6 and 3 stones respectively and ask: *how many stones are here together?* (the experimenter circles around both pairs of stones at once).



Item 23

Put two groups of 3 and 2 stones respectively on the table and say: *you may count these stones. Please count aloud.* The child has to count the 2 groups together, thus 1,2,3,4,5. The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together.* Count the stones and point to them when counting.

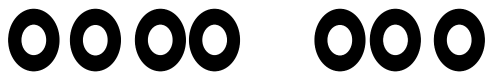
Next, the experimenter says: *look carefully.* Make one row of the two groups and ask: *how many stones are here together?* (the experimenter circles around the row).

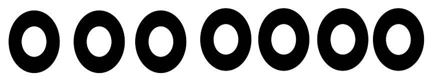


Item 24

Put two groups of 4 and 3 stones respectively on the table and say: *you may count these stones. Please count aloud.* The child has to count the 2 groups together, thus 1,2,3,4,5,6,7. The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together*. Count the stones and point to them when counting.

Next, the experimenter says: *look carefully.* Make one row of the two groups and ask: *how many stones are here together?* (the experimenter circles around the row).

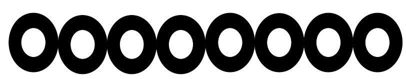




Item 25

Put two groups of 6 and 2 stones respectively on the table and say: *you may count these stones. Please count aloud.* The child has to count the 2 groups together, thus 1,2,3,4,5,6,7,8. The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together*. Count the stones and point to them when counting.

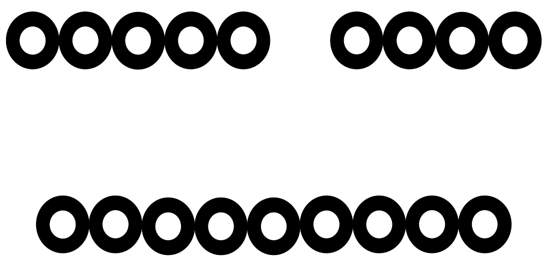
Next, the experimenter says: *look carefully.* Make one row of the two groups and ask: *how many stones are here together?* (the experimenter circles around the row).



Item 26

Put two groups of 5 and 4 stones respectively on the table and say: *you may count these stones. Please count aloud.* The child has to count the 2 groups together, thus 1,2,3,4,5,6,7,8,9. The experimenter corrects the child if needed: *you didn't count correctly, we'll do it together*. Count the stones and point to them when counting.

Next, the experimenter says: *look carefully*. Make one row of the two groups and ask: *how many stones are here together?* (the experimenter circles around the row).



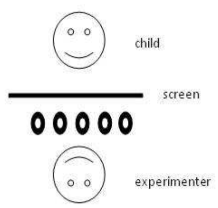
ADDITION AND SUBTRACTION WITH CHECKER PIECES (STONES)

Instruction

Practice item

The experimenter gives the child 10 stones of the same color (the experimenter also has 10 stones of the same color as the child).

Put 5 stones on the table and say: *here are 5 stones, you see?* Next, place a screen between the child and the stones (the child can no longer see the stones) and ask: *how many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*



After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 5 stones and you have **xxxx** stones. So we need to add/remove **xx** stones.* When finished, let the child put the stones together and start the next item.

Item 1 (2+1)

Put 2 stones on the table and say: *look I have 2 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm adding 1 stone* (the experimenter adds 1 stone to the ones that are already behind the screen). *how many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 3 stones and you have xxxx stones. So we need to add/remove xxxx stones.* When finished, let the child put the stones together and start the next item.

Item 2 (4+3)

Put 4 stones on the table and say: *look I have 4 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm adding 3 stones* (the experimenter adds 3 stones to the ones that are already behind the screen). *how many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 7 stones and you have xxxx stones. So we need to add/remove xxxx stones.* When finished, let the child put the stones together and start the next item.

Item 3 (2+4)

Put 2 stones on the table and say: *look I have 4 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm adding 4 stones* (the experimenter adds 4 stones to the ones that are already behind the screen). *How many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 6 stones and you have xxxx stones. So we need to add/remove xxxx stones.* When finished, let the child put the stones together and start the next item.

Item 4 (3+2)

Put 3 stones on the table and say: *look I have 3 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm adding 2 stones* (the experimenter adds 2 stones to the ones that are already behind the screen). *How many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 5 stones and you have xxxx stones. So we need to add/remove xxxx stones.* When finished, let the child put the stones together and start the next item.

Item 5 (3-1)

Put 3 stones on the table and say: *Look I have 3 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm removing 1 stone* (the experimenter removes 1 stone from the ones that are already behind the screen). *how many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this* *isn't correct. Look, I have 2 stones and you have xxxx stones. So we need to add/remove xxxx stones.*

When finished, let the child put the stones together and start the next item.

Item 6 (7-3)

Put 7 stones on the table and say: *look I have 7 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm removing 3 stones* (the experimenter removes 3 stones from the ones that are already behind the screen). *How many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 4 stones and you have xxxx stones. So we need to add/remove xxxx stones.*

When finished, let the child put the stones together and start the next item.

Item 7 (5-2)

Put 5 stones on the table and say: *look I have 5 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm removing 2 stones* (the experimenter removes 2 stones from the ones that are already behind the screen). *How many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child's response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn't correct. Look, I have 2 stones and you have xxxx stones. So we need to add/remove xxxx stones.*

When finished, let the child put the stones together and start the next item.

Item 8 (6-4)

Put 6 stones on the table and say: *look I have 6 stones.* Put the screen between the stones and the child and say: *I'm placing the screen on the table. Pay attention: I'm removing 4 stones* (the experimenter removes 4 stones from the ones that are already behind the screen). *how many stones do I have here behind the screen? Use your own stones to show me how many there are and count them.*

After the child’s response, the experimenter removes the screen and checks whether the response was correct or not. In case of a correct response, say: *well done!* In case of an incorrect response, say: *this isn’t correct. Look, I have 2 stones and you have xxxx stones. So we need to add/remove xxxx stones.* When finished, let the child put the stones together and start the next item.

ADDITION AND SUBTRACTION WITHIN A STORY CONTEXT

Place the checker pieces out sight of the child and put the screen away.

Instruction

The experimenter says: *I’m going to tell you a short story and ask you something about it. Listen carefully*.

After the child’s response, continue with the next item. **Do not give feedback about correct or incorrect.**

Item 9 (2+1)

Say: *This story is about John and Mary. John has 2 apples and Mary gives him1 apple. How many apples does John have now?*

Item 10 (4+3)

Say: This story is about Mutinta and Sililo. Mutinta has 4 guavas. Sililo gives her other 3 guavas. How many guavas does Mutinta have now?

Item 11 (2+4)

Say: This story is about Namwinga and Phiri. Namwinga has 2 bananas, Phiri gives her 4 other bananas. How many bananas does Namwinga have now?

Item 12 (3+2)

Say: This story is about Kunda and Suzyo. Kunda has 3 pencils. Suzyo gives him 2 other pencils. How many pencils does Kunda have now?

Item 13 (3-1)

Say: This story is about Peter and Jane. Peter has 3 sweets. He takes away 1 sweet and gives it Jane. How many sweets does Peter have now?

Item 14 (7-3)

Say: This story is about Esther and Ireen. Esther has seven balls. She takes away 3 balls and gives them to Ireen. How many balls does Esther have now?

Item 15 (5-2)

Say: This story is about Dan and Joe. Dan has 5 stones. He takes away 2 stones and gives them to Joe. How many stones does Dan have now?

Item 16 (6-4)

Say: This story is about Luyando and Chileshe. Luyando has 6 mangoes. She takes away 4 mangoes and gives them to Chileshe. How many mangoes does Luyando have now?

ADDITION AND SUBTRACTION

Instruction

NB. If the child is hesitating, please encourage him/her to try. **Do not give feedback about correct/incorrect.**

We'll do another exercise. Listen carefully.

Item 16 (2+1)

Say: *How much is 2 plus 1?*

Item 17 (4+3)

Say: *How much is 4 plus 3?*

Item 18 (2+4)

Say: *How much is 2 plus 4?*

Item 19 (3+2)

Say: *How much is 3 plus 2?*

Item 20 (3-1)

Say: *How much is 3 minus 1?*

Item 21 (7-3)

Say: *How much is 7 minus 3?*

Item 22 (5-2)

Say: *How much is 5 minus 2?*

Item 23 (6-4)

Say: *How much is 6 minus 4?*

ESTIMATION

Remarks

- you need the 5 cards with dots on it (3,8,15,25, and 35 dots respectively)
- **Do not give feedback about correct/incorrect**

Instruction

The experimenter says: *On the cards here are dots. I will show you each card very shortly and then you may guess how many dots there are on the card. You don't have to count them!*

Item 24 (3 dots)

Show the child the card with 3 dots on it and say: *Look at the card, pay attention, I'm turning the card now* (the child can no longer see the dots). *You may guess: how many dots were on the card you just saw?*

Item 25 (8 dots)

Show the child the card with 8 dots on it and say: *Look at the card, pay attention, I'm turning the card now* (the child can no longer see the dots). *You may guess: how many dots were on the card you just saw?*

Item 26 (15 dots)

Show the child the card with 15 dots on it and say: *Look at the card, pay attention, I'm turning the card now* (the child can no longer see the dots). *You may guess: how many dots were on the card you just saw?*

Item 27 (25 dots)

Show the child the card with 25 dots on it and say: *Look at the card, pay attention, I'm turning the card now* (the child can no longer see the dots). *You may guess: how many dots were on the card you just saw?*

Item 28 (35 dots)

Show the child the card with 35 dots on it and say: *Look at the card, pay attention, I'm turning the card now* (the child can no longer see the dots). *You may guess: how many dots were on the card you just saw?*

DLE-TEST MENTAL ARITHMETIC

Get the exercise form and let the child start with the addition sums.

Time limit: two minutes!

Instruction

We're going to do some addition sums. Show the child the exercise form and say: *you need to start at the top corner and make this block of sums. When finished with the first block, continue with the next block and so on* (point on the sheet when telling the procedure). *Fill in the answers right here* (point to the blank spots at the end of each sum). *You're not allowed to skip one! Okay? Are you ready, let's go!*

After two minutes, the child has to stop!

Also do the subtraction sums, following the same procedure as for the addition sums.

Appendix 8:Mathematics Assessment Battery Scoring Sheet

Mathematics Assessment Battery Scoring Sheet

Child's name	
Child ID Number	
School	
Name of the scoring person	
Scoring date	

CARDINALITY	1st question: how many stars counted?	2nd question: answer of the child
Item 1		
Item 2		
Item 3		
Item 4		
Item 5		

COUNTING TILL 20	write down till which number the child was able to count	
COUNTING PRINCIPLES	Did Kalulu count correctly? Answer of the child: 1 = yes 0 = no	How many stones did the child count?
Item 4 1 – 1 correspondence		
Item 5 Abstraction: pseudo error		
Item 6 1 – 1 correspondence; order irrelevant		
Item 7 1 – 1 correspondence; counting in a circle		
Item 8 1 – 1 correspondence; unordered stones		
Item 9 Abstraction: pseudo error		
Item 10 1 – 1 correspondence; counting in a circle		
Item 11 1 – 1 correspondence; order irrelevant: pseudo error		

NUMBER KNOWLEDGE-NUMBER FLASHED ON COMPUTER SCREEN	**answer of the child**	**correct (1) / incorrect (0)**
Number flashed 1		
Number flashed 13		
Number flashed 4		
Number flashed 17		
Number flashed 2		
Number flashed 11		
Number flashed 8		
Number flashed 14		
Number flashed 20		
Number flashed 5		
Number flashed 16		
Number flashed 3		
Number flashed 12		
Number flashed 6		
Number flashed 0		
Number flashed 19		
Number flashed 7		
Number flashed 15		
Number flashed 9		
Number flashed 18		
Number flashed 10		
NUMBER KNOWLEDGE	**answer of the child**	**correct (1) / incorrect (0)**
Item 15: which number precedes 7		
Item 16: 9 or 2, which number is bigger?		
Item 17: which number precedes 5?		
Item 18: 4 or 3, which number is smaller?		
CONSERVATION PRINCIPLE	**answer of the child**	**correct (1) / incorrect (0) correct is: without counting directly seeing that the number remains the same**
Item 19 (4 stones)		
Item 20 (6 stones)		
Item 21 (8 stones)		

Item 22 (9 stones)			
Item 23 (3 and 2; total 5)			
Item 24 (4 and 3; total 7)			
Item 25 (6 and 2; total 8)			
Item 26 (5 and 4; total 9)			
ADDITION & SUBTRACTION WITH MATERIAL	**Answer of the child. If the answer is different from the number of stones placed on the table by the child, write down both the answer and the number of stones.**		**correct (1) / incorrect (0)**
	number of stones	**answer of the child**	
Item 1 (2+1)			
Item 2 (4+3)			
Item 3(2+4)			
Item 4 (3+2)			
Item 5 (3-1)			
Item 6 (7-3)			
Item 7 (5-2)			
Item 8 (6-4)			
ADDITION & SUBTRACTION WITHIN STORY CONTEXT	**answer of the child**		**Correct (1) / incorrect (0)**
Item 9 (2+1)			
Item 10 (4+3)			
Item 11(2+4)			
Item 12 (3+2)			
Item 13 (3-1)			
Item 14 (7-3)			
Item 15 (5-2)			
Item 16 (6-4)			
ADDITION & SUBTRACTION (ABSTRACT)	**answer of the child**		**Correct (1) / incorrect (0)**
Item 17 (2+1)			
Item 18 (4+3)			
Item 19(2+4)			
Item 20 (3+2)			
Item 21 (3-1)			
Item 22 (7-3)			

Item 23 (5-2)		
Item 24 (6-4)		

ESTIMATION	**answer of the child**	**distance from the exact number of dots** +/- **…….**	**Within 25% of the exact number of dots 1=yes 0= no**
Item 25 (3 dots)			
Item 26 (8 dots)			
Item 27 (15 dots)			
Item 28 (25 dots)			
Item 29 (35 dots)			

Appendix 9: ECG MEASUREMENT PROTOCOL

ECG MEASUREMENT PROTOCOL

USING THE VU-AMS 5fs

Step 1:

Prepare the room by ensuring that is it clean with enough furniture (at least two tables where to place the computer and other materials and at least four chairs for the researcher, research assistant (s) and the child). The chair for the child should be next to the researcher's, near the table.

The computer should be displayed on the table while connected to power with a fully charged battery especially at the beginning of the day. The UV-AMS device, electrodes, alcohol, cotton wool and a waste bin/bag should all be available in the room. The VU-AMS device should be on the table next to the computer.

Participants' register and ECG measurement registration forms should on the table. The video camera should be mounted on the stand in an appropriate corner in the room. The camera should be positioned to face the child and the researcher so that key ECG measurement activities are captured clearly by picture and by sound. The camera should have a fully charged battery system with well tested sound and picture qualities. The testing of the camera should be done on a daily basis before the start of the day's work.

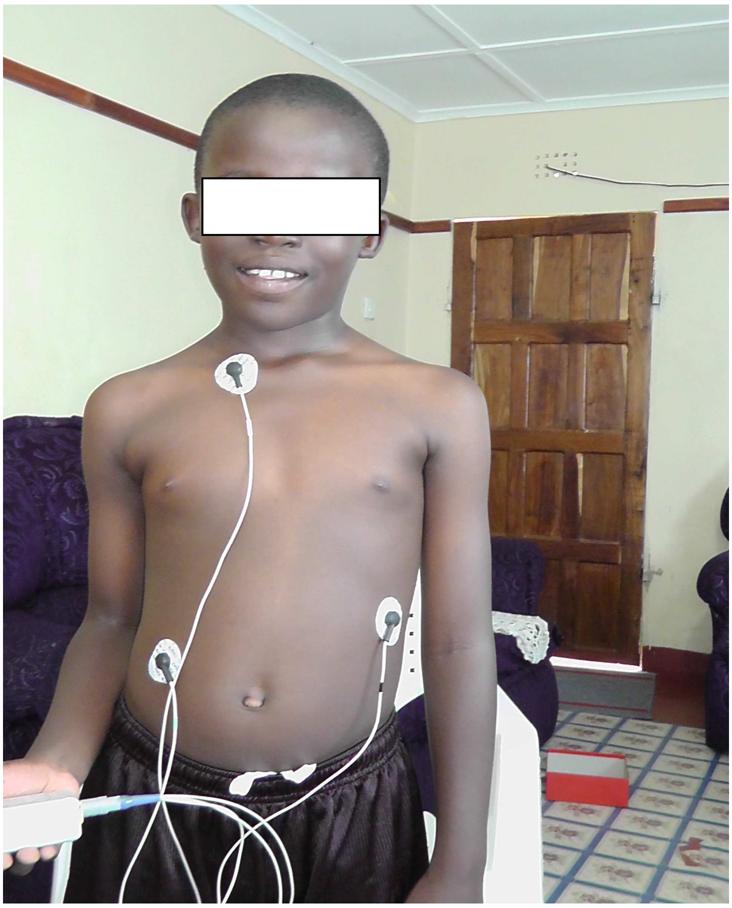
One of the research assistants should be positioned by the door, preferably outside, to prevent other people from entering the assessment room when the assessment is in progress. This same research assistant will be responsible for bringing selected children from the classroom into the assessment room. This should be so because the assessment will be conducted during children's normal learning hours. Therefore, it is important to ensure that there is total order and minimal disruption on pupils' learning schedules and other activities in the school.

Once the room and all the equipment are ready, the assessment is expected to start.

Step 2:

Welcome the child by greeting him/her. Ask the child that before the activity starts, if they need to visit the bathroom in advance. To relax the child, briefly talk about the ordinary things in their life such as the need to come to school, play with friends and being obedient at home. Then explain to the child that he/she will be with you for about 20 minutes during which time you will measure their heart-rate using the VU-AMS device (show the device). Explain that you are supposed to place three electrodes on their body (show positions where to place the three (3) electrodes.

Fig.1: Three (3) electrodes connected



Assure child that the activity to be done is safe for them and it is meant for learning purposes only. Tell the child that to place the electrodes, the child is supposed to expose the designated areas of the body, for cleaning with alcohol first and later placement of the electrodes. This may involve unbuttoning or lifting up the shirt or dress. For female children, assure them that a female research assistant will help in the cleaning and placement of electrodes. This is an important ethical concern and it will be clearly explained to parents well in advance during informed consent procedures. It's good to repeat this information and reassure the child at this particular time.

As you receive children, keep a register for children's identification (ID) particulars such as their names starting with their first names, age and gender. Always ensure that the right child is picked from the classroom by the research assistant. An example of an ID code would be: **001ebbymKPS**, where the first three characters are digits which will run serially, the next five letters pertain to the client's name(s) and the last three BLOCK letters refer to school initials such as **K**asama **P**rimary **S**chool.

Step 3:

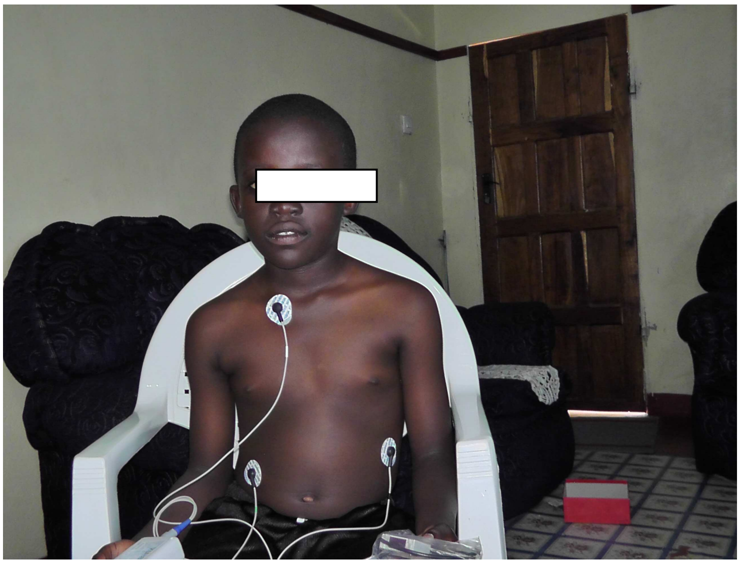
Identify the numbers and colours of the three (3) ECG electrode cables. These are differently colour-coded and are numbered from 1 to 3. Cable number 1 is white and is to be placed in the upper region on the right clavicle. Cable number 2 is green should be placed below 1 in the soft belly area below the ribs, while Cable number 3 is black and should be placed on the left side below the breast and near the last rib.

Step:4

PLACING ELECTRODES

For ECG only the white (1), green (2) and black (3) apply. These three are only placed in front.

Fig.2: How the three (3) electrodes are connected in readiness for ECG measurement



Using the above pictures, you explain how the electrodes are to be placed. The child may ask a question and once they do, explain their concern clearly and with positive assurance.

To place the electrodes, start by cleaning each body area of the child with alcohol before sticking an electrode. You should tick electrodes 1, 2 and 3 in the right places according to picture.

Note: Always refer to picture to stick the correct electrodes in the right region.

Step 5:

Once the electrodes are stuck in their rightful in places let child sit on a chair. You should now prepare to connect the equipment. Put the two batteries in the VU-AMS device by opening the battery cover below the device. Ensure that the battery-terminals are rightly identified (i.e. + and – terminals) and the two batteries are correctly fitted. Before batteries are fitted, ensure that the memory card is in the right place as it can be seen once the battery cover is removed. The memory card is positioned next to the batteries. In the VU-AMS device, the memory card is put upside down while in the external memory card reader, it is put the other way round. Close the battery cover.

Fig.3: VU-AMS device with batteries and cover removed

Step 6:

Carefully, correctly and firmly push the VU-AMS cable in the VU-AMS device. The ECG cable is blue and VU-AMS slot for this cable is blue as well. The cable terminal which goes into this slot has two grooves which set the position for easy and correct pushing-in of the cable. Then push the other side of the same cable into the laptop pot behind or on the sides of the laptop depending on where the pot is located. This is done the same way as we push the USB stick or the beamer cables into the laptop. Put the VU-AMS device on the table next to the monitor. The child should now be seated with electrode cables connected to the VU-AMS device which by this time should be connected to the laptop computer.

Step 7:

Once the equipment is set and connected as described above, on the desk top of your computer, go to all programmers from the start menu and get to the on **VU-DAMS.** Click on it and a dialogue box will appear on the monitor. Select by clicking on Device. Select connect using serial cable.

Step 8:

Another dialogue box will appear. In the dialogue box go to set parameters, do the Child ID settings entering the right identification code allocated to each child. This is a very important part as it differentiates one child from the other. The allocation of ID codes should be correctly done in advance before the measurement starts. In the dialogue box, also check for the battery voltage and ensure that your batteries have good voltage which should be above 3.21 volts. Voltage below 2.8 voltage is not very safe to operate with.

From the same dialogue box, you also need to select and set the warnings which accompany ECG measurement by clicking or ticking in the appropriate boxes. These settings help to signal to you in case something goes wrong e.g. if there is a loose electrode somewhere during the measurement process, a beeping sound will be heard and you have to check for what could be wrong. (see types of beeps in step 12).

Step 9:

Send the settings from your computer to the memory card by clicking on **send settings**. This is in the dialogue box on the computer monitor. Wait for the status of your setting through a dialogue box again to which you should respond by clicking **ok** if everything is okay. Once settings are correctly selected and sent from computer to memory card, another dialogue box appears for confirmation. This dialogue box can still show whether the earlier settings are not correct so that you can correctly do it then.

Step 10:

In the same dialogue box on the laptop monitor, click on **online**. Then select **ECG** from the option list of several measurements which the VU-AMS device can measure. In case ECG is already selected, no need to conduct this action.

Step 11:

Observe for ECG wave from for heart rate displayed as high bump, high peak getting lower, then small pump, etc. described as P,Q,R,S. This display is simply for checking if the signal is there and is okay, or if something needs to be adjusted. A good signal is between S and R and should be about 5millivolts (mv).

The signal range can be adjusted using auto scale or manually doing so. The scale range should be between +30 and -30. A uniform scale needs to be maintained for all participants in a particular study. If the signal does not show such a pattern, then the connections, especially the electrode positions and their firmness could be faulty. Check them again and observe the nature of the ECG signal until it is satisfactory.

Step 12:

Once everything is okay, look to the dialogue box which is still visible on the laptop monitor; click **START**. You will hear one long beep sound. This means now that you are starting the actual ECG (heart-rate) measurement. The actual ECG measurement is not necessarily done via the laptop.

There are other signals and warning sounds which include the following: For example, normal operation signals are in green and errors are in red.