

**The Role of Executive Functioning in Early Numeracy Attainment A case of Selected  
Government Primary Schools in Lusaka District**

By

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## **DECLARATION**

I **Hellen Kalumba Chalwe**, do hereby solemnly declare that this dissertation represents my own hard work and dedication and do hereby state that it has not previously been submitted by anyone for a degree at this or any other institution, and that all material contained herein has been duly acknowledged. I furthermore declare that the views and opinions contained in this report do not in any way represent those of the University of Zambia.

**CERTIFICATE OF APPROVAL**

This dissertation of **Hellen Kalumba Chalwe** is approved as fulfilling the partial requirements for the award of the degree of master of education in Educational Psychology of the University of Zambia.

Signed .....Date .....

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## **DEDICATION**

It is unusual that an individual finds an opportunity to thank the people that matter the most in their life. I, therefore, dedicate this work to my Father in heaven for the grace and uncommon favors he has shown to me throughout my study. I also dedicate this work to my husband Mr. Josphat Chikwanka for his endless backing and inspiration even in times when he had plentiful of his own work. He was always there for me. Mr. Chikwanka I thank you so much and will always love you. I also dedicate this work to my three sons Mapalo, Chichetekelo and Bukata.

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## **ABBREVIATIONS**

<b>BRIEF</b>	Behavioral Rating Inventory of Executive Function
<b>CE</b>	Central Executive
<b>DEBS</b>	District Education Board Secretary
<b>DRGS</b>	Directorate of Research and Graduate Studies
<b>EF</b>	Executive functioning
<b>LTM</b>	Long Term Memory
<b>MoGE</b>	Ministry of General Education
<b>SES</b>	Socio Economic Status
<b>UNZA</b>	University of Zambia
<b>WM</b>	Working Memory

## ABSTRACT

The purpose of this research was to examine the role of executive functioning in numeracy attainment in the second grade in selected government primary schools in Lusaka District. The objectives were to determine the executive function skills level in learners in the second grade; determine learner's performance in numeracy; and establish whether there is an association between executive function and numeracy attainment in the second grade.

The study adopted a quasi-experimental design. The target population was all second-grade learners and their teachers in Lusaka District. A total sample of 252 respondents were selected. Learners were randomly selected with the help of their teachers who helped in giving information on their learners using the Behavioral Rating Inventory for Executive Functions (BRIEF) questionnaire. Standard tests (DLE, BRIEF and Mathematics Battery test) were conducted to determine learners' performance in numeracy and executive functioning. Quantitative data were analyzed using the Statistical Package for Social Science (SPSS) version 23 to run various statistical tests such as Descriptive, cross tabulations correlations and t-tests. The findings in this study did not show an associations between the overall executive functioning but (individual) and numeracy in the second grade. It was also established demographic factors such as age, gender and location of schools were are associated with executive functioning.

However, the study found that the general performance in mathematics was good. The location was Similar and did not differ in performance whether children came from Low, medium and high density schools. The conclusion of this study was that learning numeracy is associated planning and organisation and working memory. Therefore, the ability to plan plays an important role in early numeracy attainment in the second grade.

Based on the findings, the following recommendation were made:

1. Zambian Primary education should integrate executive function (working memory and planning & organization) skills in their curriculum so that these essential skills can be stimulated at elementary grades. However, the researcher recommends that teacher training in both colleges and universities must incorporate how to stimulate executive functions in children through the Ministry of General Education.
2. Since learners' career encourages performance, career guidance is necessary to help learners get a better understanding of the importance of numeracy beyond primary school.
3. Ministry of General Education must ensure that through Continuous Professional Development (CPD) teachers in primary schools are oriented on the importance of executive functioning skills in numeracy attainment in second grades so that teachers can share the experiences on the ways to enhance learners' abilities.

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# CHAPTER ONE

## INTRODUCTION

### **1.1 Overview**

This chapter presents the background of the study, statement of the problem, purpose of the study, research objectives and questions, significance of the study, limitations and delimitations of the study. The theoretical framework and operational definitions of terms used in this study are also discussed.

### **1.2 Background of the study**

Kombo and Tromp (2014), explain that, the background of the study refers to the setting or position of the study. They further state that the background of the study gives a brief overview of the problem the researcher aspires to tackle. Thus, the following background sets the basis for conducting this study.

Executive functions are processes that support many everyday activities, including planning, flexible thinking, focused attention, behavioral inhibition, and show continued development into early adulthood. One significant background to the development of these mental abilities is the structural and functional development of the brain (Collette, et al (1999). Among the slowest developing brain regions is the prefrontal cortex, a large expanse of cortex located in the front half of the brain. Strangely, this region of the brain continues to develop into the third period of life. Brain imaging research and studies of patients with brain damage, suggest that the prefrontal cortex is vital for controlling attention, thought and behavior in share since it links perceptual, emotional and motor control centers located elsewhere in brain (Best, Miller and Jones, 2009).

The fact that prefrontal cortex is both slow to develop and important for executive control has led to the suggestion that the development of executive functioning is closely connected to the development of the prefrontal cortex. The suggestion is that basic normal tasks, such as not playing with some prohibited things, will be difficult even for typically developing children. (Goldberg, 2001)

Considering that the prefrontal cortex is important for behavioral self-regulation and develops gradually may offer awareness into why, for example, some children in primary grade have

difficulty in stopping one activity and switching to a new one and planning ahead; doing more than one thing at a time; concentrating for long periods of time and foregoing immediate rewards (Agostino, Johnson and Pascual-Leone, 2010).

Findings from developmental cognitive neuroscience research suggests these behaviors as normal part of growing up and are rooted to some degree in how the brain works at this early stage in life (psychology 560 cognitive neuroscience, 2009). Further, Diamond, (2013) reported that it is extremely challenging that executive functions are difficult to exactly define and measure, in part because core concepts such as inhibition and cognitive flexibility actually do more to describe than explain behavior. It is unclear whether processes involved in regulating one kind of behavior, such as language, are the same as those involved in regulating other kinds of behavior, such as the emotions. Tasks that are appropriate for testing executive functioning at one age will not typically be suitable for testing executive functioning in older children. This makes it difficult to compare executive functioning in children of different ages. The current study used the Behaviour Rating Inventory for Executive function to rate executive functioning skills in pupils. This tool has proved to be reliable and has been used before in Zambia among first graders (Mubanga 2015) and first graders (Mwanza-Kabaghe 2015).

The study of executive function originated from observations of adults with damage to the frontal lobe of the brain and the study of these patients has led to a very strong link in research between executive processes and frontal lobe function. Executive function skills begin to emerge in infancy but are among the last cognitive abilities to mature, continuing to develop into late adolescence. (Huizinga, Dolan, and van der Molen, 2006) Executive function (EF) is the name given to the group of processes that allow people to respond flexibly to the environment and engage in deliberate, goal-directed, thought and action. Executive function forms the basis of abilities such as problem solving and flexible thinking. Most likely to be used in the absence of external guidance or when a situation is new (Bull, Espy, and Wiebe, 2008; Monette, Bigras, and Guay, 2011; Roebbers, et al. 2012; St. Clair-Thompson and Gathercole, 2006).

Empirical evidence from studies show that integrating the development of executive functioning skills while solving early numeracy tasks was connected with development in skills. Executive functions are correlated to the attainment of numeracy (Blair and Razza, 2007; St. Clair-Thompson

and Gathercole, 2004). While the foresaid studies established this empirical evidence among the pre-grade in kindergarten, it is not known whether this is true for second grade learners.

The three Executive functioning skills which are most commonly studied, within developmental literature, are (i) *inhibition*: suppressing distracting information and unwanted responses, (ii) *shifting*: flexibly switching between different tasks, and (iii) *updating or working memory*: monitoring and manipulating information in mind. The three main types of executive functioning skills can all be beneficial in a school setting. For example, improved working memory allows a child to hold more material for extensive period of time and psychologically practice the information so that it can be effectively merged into long term memory (Baddeley, 1996). However, it is not known whether or not the second grade learner can have the ability to hold more materials for extensive period of time in order to attain numeracy skills with the help of executive functions a justification enough for the current study.

The relationship between behavior regulation, including executive function, and academic achievement has been widely studied in elementary school children but not so often in the youngest groups (Alexander, Entwisle and Dauber, 1993; Bull and Scerif, 2001; McClelland et al. 2007). These studies were done elsewhere but in Zambia and Lusaka particularly in the second grade, it is not known if this is the case.

A key goal of school is the development of children's numerical skills. All learners, including those with disabilities and those at risk of school failure, need to acquire the knowledge and skills that will enable them to perform math-related problems that they encounter at school, in their daily lives, and future occupation. Although research in numeracy has lagged behind than of reading. (Paglin and Rufolo, 1990; Rivera-Batiz, 1992). In Zambia, very few studies have looked at EF and numeracy (Mwanza, 2011; Mwanza-Kabaghe, 2015; and Mubanga, 2015). Mwanza –Kabaghe (2015) examined pre-school executive functions and oral language as predictor of literacy and numeracy in the first grade. The study revealed that pre-school did not promote executive functions but executive functions do predict literacy and numeracy skills. She also found that executive functions are better predictor of numeracy than literacy. Mubanga (2015) examined the acquisition of grade-level executive function in early literacy and numeracy skills in the first grade and found that children's performance in literacy and numeracy skills was generally low. The current study is different from the aforementioned studies as it exclusively looked at numeracy and not literacy.

Empirical evidence has shown the relevancy of executive functioning in numeracy attainment (Anderson, 2008; Garthecole et al., 2004; Swanson Beebe-Frankenberger, 2004; Letho, 1995; and Mwanza- Kabaghe, 2015). However, no study has explicitly looked at the role of executive functioning in numeracy attainment in the second grade particularly in Lusaka, Zambia a gap the current study intended to fill.

### **1.3 Statement of the problem**

The last decade has witnessed substantial growth in the number of studies examining executive functioning (EF) and its relation to numeracy attainment. Regardless of the number of studies done in the area of executive functioning, not much literature has been documented and reported on the connection between executive functions and numeracy attainment (Anderson, 2008; Garthecole et al., 2004; Swanson Beebe Frankenberger, 2004; Letho, 1995); (Mwanza- Kabaghe, 2015). This study therefore intended to fill the lacuna as well as show the importance of executive functioning in numeracy attainment.

### **1.4 Purpose of the study**

The purpose of this study was to examine the role of executive functioning in early numeracy attainment in the second grade in selected government primary schools in Lusaka District.

### **1.5 Research objectives**

#### **1.5.1 General objective**

The general objective of the study was to determine the role of executive functions in numeracy attainment in the second grade.

#### **1.6 Specific objectives**

This study was guided by the following objectives:

1. To determine executive function skills in learners in the second grade.
2. To determine learner's performance in numeracy in the second grade.
3. To establish whether there is an association between executive functions and numeracy performance in the second grade.

## **1.7 Research questions**

This study was guided by the following research questions:

1. What are executive functions levels among the learners in the second grade?
2. How is the performance of learners in numeracy in the second grade?
3. Is there an association between executive functions and numeracy attainment in the second grade?

## **1.8 Significance of the study**

Kerlinger (1973), in Kombo and Tromp (2014:49), defines significance of the study as “the rationale of the study that bears materials which justifies the study and shows its importance.” The significance of the study also elaborates on the importance and implications of a study for researchers, practitioners and policy makers. It therefore, addresses the potential value of the study and identifies the audience for the study. It should also be pointed out how the outcomes will be of benefit to the audience (Creswell, 2009).

The study is significant in that it provides understandings into the role of executive functioning in numeracy attainment which is vital for every learner to receive quality education through holistic learning.

Further, it is also hoped that the information resulting from this study may assist to inform the Ministry of General Education and other stakeholders interested in early numeracy development to come up with best practices aimed at facilitating the attainment skills from primary school among second graders.

The findings may also inform curriculum developers to consider incorporating executive functioning stimulation when designing a curriculum.

Furthermore, the findings may stimulate further research especially that little research has been done in Zambia on executive functioning.

### **1.9 Limitations of the study**

This study was conducted in Lusaka District only hence its findings may not be generalized to other settings because there was no representation of all provinces in Zambia.

### **1.10 Delimitation of the study**

The scope of the study was confined to Lusaka District in Zambia and only six number of schools were involved.

### **1.11 Theoretical frame work**

This study was guided by Baddeley's multi component model (1996). This model stipulates that there is a relationship between working memory and numeracy calculation. Baddeley & Hitch proposed their three part working memory model as an alternative to the short-term store in Atkinson & Shiffrin's 'multi-store' memory model (1968). This model was later expanded upon by Baddeley and other co-workers to add a fourth component, and has become the dominant view in the field of working memory. However, alternative models are developing providing a different perspective on the working memory system.

The original model of Baddeley & Hitch was composed of three main components; the central executive which acts as supervisory system and controls the flow of information from and to its slave systems: the phonological loop and the visuo-spatial sketchpad. The phonological loop stores verbal content, whereas the visuo-spatial sketchpad caters for visuo-spatial data. Both the slave systems only function as short-term storage centers.

In 2000 Baddeley added a third slave system to his model, the episodic buffer which included other cognitive processes such as inhibitory control, shifting and organization which have received little attention although they are useful in numeracy as suggested by the model. Therefore, the selection of this model was based on the assumption that executive function improves numeracy attainment in second grade learners.

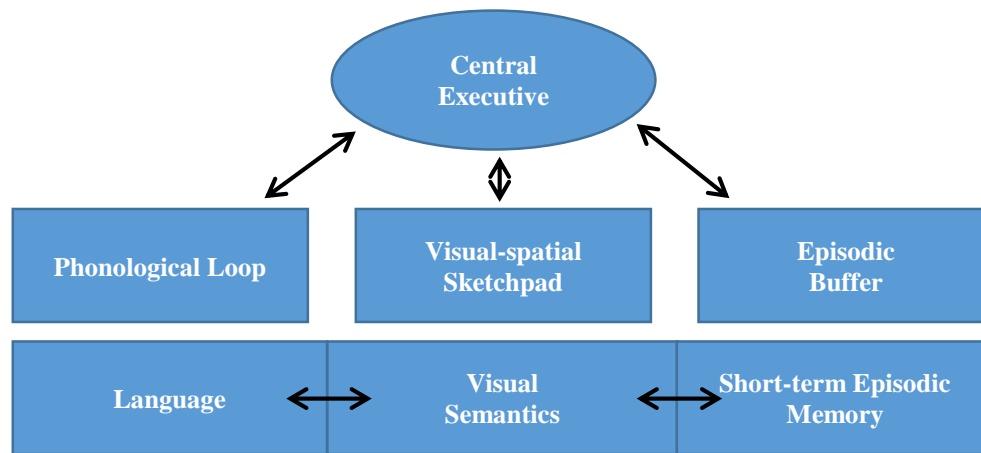


Figure 1.1 (Source: Baddeley, 2000)

### 1.12 Definitions of terms

The definition of concepts provides the context in which the terms have been used in the study Cohen et al (2007). The researcher was obliged to define each term as she wanted the reader to know what they stood for. Thus, the section below is the list of the terms that have been used in this study.

**Attainment:** something completed successfully.

**Central Executive:** one part of three components of working memory.

**Childhood:** a person's state of being 7 – 10 years old

**Cognition:** mental action or process of acquiring knowledge and understanding through thoughts, experience, and the senses.

**Executive functions:** a set of cognitive abilities that control and regulate behaviours that are required for learning. These include working memory, inhibitory skills, and attention.

**Inhibition:** ability to deliberately inhibit dominant, automatic.

**Mathematics:** Practice of solving simple addition problems.

**Numeracy:** skills with numbers and mathematics

**Second grade:** Second school year after first grade (mostly learners are 7-8 years of age old)

**Shifting:** Ability to switch attention between strategies or response sets

**Working Memory:** A person's short-term memory lasting not more than 9 seconds

**Frontal lobe:** Front section

**Brain:** Intelligence

### **1.13 Summary**

This Chapter presented the background information for this study. It showed the problem area. The statement of the problem, purpose of the study, specific research objectives, and research questions, significance of the study, Limitation, delimitations and definitions of concepts were also presented. The next chapter reviews literature relevant to the study, in an attempt to establish the role of executive functioning in numeracy attainment in the second grade in Lusaka District Zambia.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1. Overview**

This next chapter looks at literature review according to sub themes in line with study objectives which included to; determine executive functioning skills of learners in the second grade, determine learner's performance in numeracy in the second grade and establish whether or not there is an association between executive functions and numeracy performance in the second grade.

##### **2.1.1. Executive function**

Executive function (EF) is involved in planning and represents the ability to think flexibly and regulate behaviors. Diamond, Barnett, Thomas, and Munro, (2007) defined Executive function as the ability to engage in deliberate, goal-directed thought and action through the use of inhibitory control. There is a substantial evidence that Executive functions plays an important role in learning during childhood (Bull, Johnson, and Roy 1999; Bull and Scerif, 2001; Lethto, 1995; Lorschach, Wilson and Reimer 1996; McLean and Hitch, 1999; Ozonoff and Jensen, 1999; Russell, Jarrold, and Henry, 1996).

Executive functions are a family of control functions needed when one has to concentrate and think. These functions depend on neural circuit in which the prefrontal cortex plays a prominent role (Anderson, Jacobs and Anderson, 2008; Bialystok and Craik, 2005). There is a general agreement that there are three core EFs: inhibition (also called "inhibitory control"), working memory, and shifting. (Miyake et al., 2000). These form the foundation for higher-order EFs, such as reasoning, problem solving, and planning (Christoff, Ream, Geddes, and Gabrieli, 2003).

Agostino, Johnson, and Pascual-Leone, (2010) conducted a study titled Executive functions underlying multiplicative reasoning: Problem type matters, the purpose was to support the key role of EF in young children's academic attainment in Colombia. The findings clearly demonstrate that preschool children continue to enhance their EF performance during their transition to school. Moreover, the study revealed that EF changes measured with tasks tapping inhibition, working memory, and cognitive flexibility were substantial. From the study above, it had been observed

that Colombian preschool children demonstrate that they continue enhancing EF performance during their transition in school. However, this study is different in that it measured EF using BRIEF and not the tapping test. .

Similarly Best, and Miller, (2009), in the study developmental perspective on executive function Child Development in Britain learners from grade 1 to grade 2, found that children improved their EF performance by one-half to three-quarters of a standard deviation in EF performance over any 12-month period. Interestingly, the magnitude of changes in EF was larger for the younger group compared to the older group, at least in two EF measures inhibition, and working memory. Furthermore, subsequent analyses revealed that the improvement in EF performance was significantly larger for preschoolers from pre-kindergarten to kindergarten than school-age children. (Best and Miller 2009; Davidson et al., 2006).The current study had a lot to learn from the aforementioned study in that both studies involved same age group range. The difference however, is that Best and Miller (2009) did a longitudinal study while the current study was a quasi-experimental study.

Longitudinal studies conducted by Miyake and Friedman (2012) titled Executive function in Early Childhood in the United State of America. The findings revealed that nonlinearity in the rate of EF development was shown in preschoolers insofar as mean levels of changes in EF were larger for the younger than for the older children aged 3 to 4 verses 4 to 5 years; Corresponding, pattern of nonlinear EF development has also been shown in school-age children such as a lesser improvement in EF throughout grades 3 to 6 compared to earlier grades.

Kochanska et al., (2000), Karbach, and Kray (2009), Miyake and Friedman (2012) carried out studies titled Changes in brain functioning from infancy to early childhood in London. The findings revealed that changes in brain development changes in prefrontal-based circuitry, are assumed to be related to EF development.

Therefore, a central challenge facing studies assessing EF development, is the selection of age-appropriate and age-sensitive tasks which are suitable for use over a longer period of time from primary to secondary years. In this study the selection of EF tasks seems to meet this demand insofar as neither bottom nor ceiling effects were observed regarding EF performance in the sample of 7- to 10-year olds. Accordingly, it can be assumed that the tasks are complex enough to explain individual differences in rapidly developing EF of preschool and young school age children.

Furthermore, it can be proposed that age-sensitive tasks allow the monitoring and evaluation of EF interventions during transition to school, an important point, given that there is evidence that EF trainings implemented in prekindergarten and kindergarten promote EF development (Thorell et al., 2008; Röthlisberger, Neuenschwander, Cimeli, Michel, & Roebbers, 2012).

Managing our lives includes planning and carrying out many activities, such as getting ready for a class, making sure there are supplies and time scheduled for meals or for gardening, short-term plans such as putting together the day's outfit, and long-term goals such as every week adding to a savings account for school tuition fees, and retirement. Such planning and carrying out of activities depends greatly on the *executive function* of the frontal lobes of the brain (Goldberg, 2001).

Good executive function depends on healthy frontal lobes, which are located in the top front part of the brain, right behind the forehead. The frontal lobes have control over many body functions. This part of the brain continues to develop through adolescence and into adult life. Some of the functions of the frontal lobes include managing body movement (motor function), emotions, attention, motivation, and other thinking functions such as decision-making, judgment, abstract reasoning, planning and completing tasks, working memory (storing and using details to function), and meeting goals.

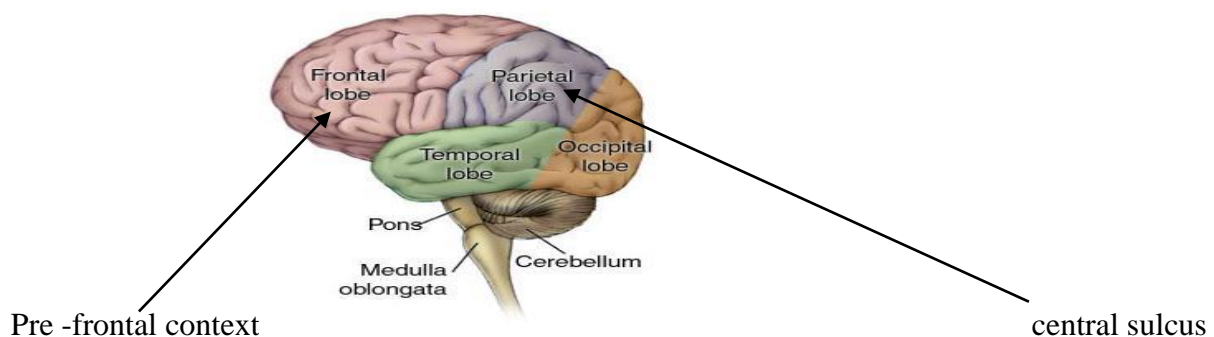


Figure 1.2: Prefrontal Cortex

(Source: Goldberg, 2001)

Clark, et al (2010) conducted a study titled normal development of the pre frontal cortex from birth to young adulthood: cognitive functions, anatomy, and biochemistry in New York. The findings were that the prefrontal cortex, often referred to as the “brain’s CEO” were part of the brain which was responsible for planning the “higher-order” thinking that separates humans from other species, and that it develops last. Another, important aspect found was that the thinking changes between ages 2 and 5, there are rapid changes in the prefrontal cortex, and these changes coincide with changes one can observe in children’s ability to succeed on executive functioning tasks.

The above study is insightful in that it has demonstrated how the brain which is responsible for planning the “higher-order” thinking that separates humans from other species, and that it develops last. Furthermore, the study is also important because it has highlighted some vital trends and benefits of executive functions to young learners. However, while the reviewed study focused on the development of the prefrontal cortex, which changes according to children’s ability to succeed on executive functioning tasks of children in New York, the current study focused on the performance of executive functions in Zambian second grade learners.

Similarly, Welsh and Pennington (1991) carried out a survey on executive functions collaboration with performance in learners aged 7 to 10 years in United Kingdom primary schools. It revealed that Executive function involves mental processes across the domain of frontal lobe functions and also includes gating of attention and memory functions for task performance. The study further, found that learners aged 7 to 10 years performed extremely well in Executive function and collaborated among several areas of the brain: dorsolateral prefrontal cortex, orbitofrontal cortex, anterior cingulate cortex, and parieto temporal association areas. In Zambia on the other hand it was not known whether the learners aged 7 to 10 can portray the same performance especially in Lusaka District. A justification for the study.

### **2.2.1 Inhibitory control**

Inhibition is defined as “the ability to ignore distraction and stay focused, and to resist making one response and instead make another, Inhibitory control is a core component of executive functioning due to its ability to use essential, sieve views and instincts to fight temptations, distractions, habits, pause and think before acting. It makes imaginable selective, attentive, and continued devotion, ordering, and act. This capacity recalls from acting as totally impulsive

persons who do whatsoever arises into the minds. It is the ability called on to push aside imaginations about what would relatively be doing to focus on imperative tasks. (Barkley, 1997).

Inhibition is important for controlling behavior for instance, overriding habitual responses, exerting self- control by resisting temptations such as the temptation to overeat or to respond impulsively rather than giving a more considerate response and exercising discipline by resisting the temptation to not complete a task; controlling attention which is selective or focused and controlling emotions so as not to act inappropriately which is an aspect of self-regulations. In Zambia, Mwanza (2011) found that children who were poor at inhibition and emotional control performed better in overcrowded classrooms than those who had Good emotional control, however, in her recent study Mwanza-Kabaghe (2015), this was not the case as those with poor inhibition and emotional control also performed poorly in numeracy. Hence it was important to assess whether this would be the case for second graders.

It is imperative for second grade learners to have Inhibition skills which can help “taste the speech” and say something nice, and to switch feelings at the same time, even when annoyed, quick, or frustrated, Children rely on this ability to delay till they are named on when they recognize the response. Moffitt, Arseneut, Belky Dickson, Hancox, Harrington and Caspi (2011) conducted a longitudinal study titled a gradient childhood self-control predicts adult health, wealth and crime in United States of America in which 1,000 children who were born in the same city and same year were followed for thirty-two years with a 96 percent retention rate. The findings were that children whose inhibition was worse had less persistence, more impulsively, and poorer attention regulation between the age of 3 to 11 grew up to have worse health, earn less money, be less happy, and committed more crimes than those who had better inhibitory control as children who grew up to have better physical and mental health, earned more as law-abiding adults thirty years later than those with worse inhibitory control as children controlling for IQ, gender, social class, and home and family circumstances during childhood.

Moffitt et al. (2011) concluded that because the effects of inhibitory control follow a linear gradient, “interventions that achieve even small improvements in inhibitory control for individuals could shift the entire distribution of outcomes in salutary direction and yield large improvement in health, wealth, and crime rate for a nation”. While the aforesaid study investigated the 1000 children born in the same city and year, the current study involved 252 children in the same town

but different age groups in the second grade measuring the role of executive functioning in numeracy attainment.

Barkley (2007) conducted a study titled behavioural inhibition, sustained attention, and Executive functions in New York, the purpose was to engage in conscious, reflective problem solving in learners in pre- grade and first grade. The findings indicated that inhibition supported other executive functions such as mental set shifting, which requires switching attention among stimuli or tasks, further, the study, found that in order to engage strategic process in favor of a long term goal, inhibition delays a proponent response in order to achieve a goal and protect that delay even in the face of interference.

Zelazo, Craik, and Booth, (2004) conducted a study titled early development of executive functions, the purpose was to review executive function across the lifespan of learners in Australia. The findings were that learners tend to inhibit certain behaviors, attention focusing and shifting, cognitive flexibility, and memory in learning.

The above study is insightful in that it has demonstrated how learners tend to inhibit certain behaviors, attention focusing and shifting, cognitive flexibility, and memory in learning. However, a key question is whether these Executive function can be applied to the second grade learners in Zambia.

Most researchers agree that inhibition is the primary executive function that precedes and allows development of other EFs s such as mental set shifting needed to suppress inappropriate strategies in addition and when subtraction is required, or prepotent number representations, with whole numbers larger numbers map to greater magnitude; when the same numbers are combined in a fraction, larger denominators represent smaller magnitude. Understanding of fractions may require inhibition of number-magnitude mappings that are applicable to whole numbers. Inhibition may also be required to suppress retrieval of number bonds (e.g., retrieving '12' for  $3+4=$ ), or utilization of information from a word problem that is irrelevant to the solution (Bull, Johnson, and Roy 1999; Bull and Scerif, 2001; Lethto, 1995; Lorschach, Wilson and Reimer 1996; McLean and Hitch, 1999; Ozonoff and Jensen, 1999; Russell, Jarrold, and Henry, 1996 and Lee, 2013).

### **2.1.3. Working memory/Updating**

Updating is important for holding relevant information during the problem solving process, and in the storage and retrieval of partial results. Alloway, Gathercole and Pickering, (2004) defined Working memory as the ability to maintain and manipulate information over brief periods of time and gradually improves from 4 to 15 years of age. This implies that it is crucial for making sense of anything that unfolds over time, for that requires holding in mind what happens earlier and relating it to what is happening now. Therefore, working memory is vital for making logic of any language data, whether spoken or received. In addition, it is also needed for psychologically rearranging items and understanding source and outcome, and expressively relating pieces of information to come a general standard or see new associations among old ideas. The question that begs answers was whether working memory is associated with numeracy for children aged 7-10.

Baddeley, (2000) conducted a study titled understanding the nature of working memory in the United Kingdom on children aged 7 to 14 the purpose was to comprehend the contribution made by executive function aspects of working memory to the acquisition of complex skills and knowledge during childhood. The findings were that the impact of working memory on academic attainment is significant. The study further found that between the ages 7 to 14, children who scored poorly on working memory measures linked with executive skills typically perform below expected standard. One of the leading theoretical accounts is the working memory model of Baddeley and Hitch (1974; 2000). At the heart of the model is the central executive, responsible for the control and regulation of cognitive process

The outcome of the above study have shown the significance of working memory to children at the ages 7 to 14 in United Kingdom and that children who scored poorly on working memory measures linked with executive skills typically perform below expected standard. It is not known whether or not this can be the case with Zambian children aged 7 to 10.

Flock, Smalley, Kitil, Galla, Kaiser-Greenland, Locke...Kasari (2010) carried out a study on effects of mindful awareness practices on executive functions in elementary school children in Britain. The study exploited 328 children and examined the impact of working memory among learners in elementary schools. They used one method of data collection which was the questionnaire under descriptive survey design which made the study quantitative. The results of

the study indicated that working memory had positive impact in the learning process and increased learners performance in both literacy and numeracy levels in schools, also the study recommended the use of activities in improving children's EFs exists for Cogmed computers-based training for working memory and reasoning, they added a combination of computerized and interactive games; task-switching computer-based training and promoting alternative thinking strategies.

The current study had a lot to learn from the aforementioned study in that both studies involved elementary learners. However, this study is different in that study it exploited 252 children and it employed hands on tests such as a mathematics Battery tests and DLE for EF, a Behavioral Rating Inventory for Executive Function (BRIEF), was given to teachers to fill in for each child for they knew their pupils due to every day school interactions.

Homes Gathercole and Dunning, (2009) carried out a study titled Working memory components as predictors of children's mathematical word problem solving study determined the working memory (WM) components that best predicted mathematical word problem-solving accuracy of elementary school children in Grades 2, 3, and 4 in China, there were three hundred and ten (310) participants. A battery of tests was administered to assess problem-solving accuracy, problem-solving processes, WM, reading, and math calculation. The findings were that all three WM components significantly predicted problem-solving accuracy, reading skills and calculation proficiency mediated the predictive effects of the central executive system and the phonological loop on solution accuracy, and academic mediators failed to moderate the relationship between the visual-spatial sketchpad and solution accuracy. The results support the notion that all components of WM play a major role in predicting problem-solving accuracy, but basic skills acquired in specific academic domains (reading and math) can compensate for some of the influence of WM on children's mathematical word problem solving.

#### **2.1.4. Attention focusing/shifting**

Shifting is the ability to flexibly shift attention as tasks demands change. Miyake et al., (2000) conducted a study titled the unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks in London and the purpose was to establish the shifting abilities between mental states, operations, or tasks. The findings were that the ability to shift mindset, is often extremely challenging especially those with learning and attention difficulties and that

shifting required learners to interpret information in more than one way, change their approach when needed and choose a new strategy when the first one is not working. This implies that shifting skills may help switching between operations, solution strategies, quantity ranges and notations between verbal digits, written Arabic symbols, and non-symbolic quantity representations, and between the steps of a complex multi-step problem.

The above study is insightful in that it has demonstrated how shifting skills has the ability to shift the mindset, it is often extremely challenging especially children with learning and attention difficulties because shifting requires learners to interpret information in more than one way, change their approach when needed and choose a new strategy when the first one is not working. However, while the reviewed study focused on children with learning and attention difficulties the current study focused on learners without special education needs. It is not known whether this is evident with children in the second grade in Zambia particularly Lusaka District.

Another study on shifting by Kroesbergen, Van Luit, Van Lieshout, Van Loosbroek and Van de Rijt (2009) titled the role of executive functions and subtilizing the ability to focus on relevant information in the first grade children in china the study found that attention shifting, is a more complex skill, involves being able to shift attention from one task to another. For example, some children have trouble shifting from break to the classroom environment, which may reflect on difficulties with perseverance. This entails that shifting is essential for effective reading, writing, numeracy and problem solving. Furthermore, in terms of numeracy shifting is essential for working efficiently and accurately. Learners often get stuck trying to solve a problem in one way when they may be an easier or more efficient way to find a solution.

The above study is insightful in that it has demonstrated how shifting has a more complex skill, involved for an individual to be able to shift attention from one task to another While the aforesaid studies was done on the ability to focus on relevant information in the first grade children in China. The current study focused on the second grade in Zambia. It is not known whether or not this would be witnessed in Zambia bearing in mind different prevailing environmental factors.

#### **2.1.5. Planning and organization**

kolkman, Hoijtink, Kroesbergen and Leseman (2013) conducted a study on learners in first and second grade on how to set goals and planning/organization in United State of America, the study

found that most learners especially those with executive functioning difficulties begin tasks impulsively with no plan of action which results in their being stuck and the end product is disorganized and incoherent. Further the study revealed that the serious EF process of planning & organization help learners understand the objective of a particular task, visualize the steps of the tasks, organize time effectively and determine the resources needed to complete the tasks.

The above study is insightful in that it has demonstrated the importance of setting goals in planning and organization. Furthermore, the study is also important because it has highlighted some vital trends and benefits of the serious EF process of planning & organization that help learners understand the objective of a particular task, visualize the steps of the tasks, organize time effectively and determine the resources needed to complete the tasks, also the consequences of those with executive functioning difficulties who begin tasks impulsively with no plan of action which results in their being stuck and the end product is disorganized and incoherent. However, while the reviewed study focused on setting goals in the first and second grade in United States of American schools, the current study focused on the role of executive functioning in numeracy attainment in the second grade in Zambia particularly in Lusaka District.

Similarly, Alloway et al (2010) carried out a study on importance of goal setting at early stage in Burundi. The results revealed that when learners set their goals, they show greater commitment and are more motivated to attain these goals, further, planning & organization was found to enhance self-efficacy, achievement and motivation. The Adam (1997)'s study has shown the importance of planning & organization in learners. It is also noted that setting goals motivate learners for they attain their goals and enhance self-efficacy. The above studies were insightful to the current study in that they provided guidance on how emerging executive functions skills in planning & organization help learners to learn at any grade level and utilize their full potential to enhance self-efficacy, achievement and motivation. Children have the ability to formulate actions in advance and to approach a task in an organized, strategic, and efficient manner. This implies that Planning & organization of information and details that should be taught systematically in schools for it is a prerequisite for writing, reading and completing projects in content areas such as mathematics, science and social studies. Therefore, it is worth undertaking a study to ascertain whether or not this could be the case for Zambian children in the second grade.

### **2.1.6. Importance of Executive functions to learners**

Executive function is very important to children for it affects not only learning and cognitive skills, but also social and emotional competencies and these are related to one another. In order for children to learn to engage in the classroom in activities such as numeracy and organized games, they must first learn to regulate their emotions and inhibit some behaviors, such as shouting out without raising their hands. Children who enter the highly structured environment of grade school who are unable to sustain attention on a task and control their behavior are more likely than their better-regulated peers to struggle in school, both socially and academically. This implies that, children who are able to regulate their behavior develop better teacher-student relationships, which has been consistently shown to be related to positive school. Executive function and the ability to self-regulate have been shown to predict academic achievement among children even several years later outcomes (Passolunghi, Lanfranchi (2012); Passolunghi, and Pazzaglia (2004); Perry and Dockett (2008); Anderson (2008); Adams and Hitch (1997)).

The above studies are vital to this study in that they brought out the benefits that children acquire when they regulate their behavior for they develop better teacher-student relationships, which has been consistently shown to be related to positive school and predict academic achievement among children even several years' later outcomes. Furthermore, the study revealed that executive functions does not only affects learning and cognitive skills, but also social and emotional competencies and these are related to one another. However, it is not known whether or not this can be the case to second grade learners in Zambia. Hence the study.

### **2.2. Learner's performance in numeracy**

Numeracy is closely related to mathematics and without a solid grounding in mathematical concepts and procedures, there can be *no* numeracy. On the other hand, knowledge of mathematical concepts and procedures *alone* is not enough to guarantee numeracy. What mathematics is taught and how it is taught has an important bearing on the development of young people's numeracy. Looked at from another point of view, mathematics is a school subject. In all schools, classes are timetabled for the teaching of mathematics but this is not the case for numeracy (Anghel, 2010).

It may therefore be helpful to think of numeracy as a key *outcome* of how mathematics is taught and learned something that is acquired and integrated with what students learn in their other school subjects, and in their wider experiences both in school and out of school. In school education, numeracy is a fundamental component of learning, discourse and critique across all areas of the curriculum. It involves the disposition to use, in context, a combination of: underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical and algebraic); mathematical thinking and strategies; general thinking skills; and grounded appreciation of context. (Bishop and Forgan, 2007).

Wood and Spelke, (2005) conducted a study titled what does it mean to teach mathematics differently? In Australia and the purpose was to expose children to develop numeracy skills. The findings were that learners begin to develop their numeracy skills comparatively fast in life and that children exist with some characteristic of numeracy skills such as the capability to recognize differences in level which can be progressed by teaching.

The above study is insightful vital to this study in that it brought out that learners begin to develop their numeracy skills comparatively fast in life and that children exist with some characteristic of numeracy skills such as the capability to recognize differences in level which can be progressed by tutoring. A reason good enough to investigate whether or not this could be the case with Zambian learners as well as check if executive functions have anything to do with this.

Of all the cognitive skills, mathematics performance has been thought to show the largest differences in favour of males. Though these differences are not usually evident in lower grade school, they emerge during adolescence, and most research concluded that boys excel in mathematical ability (wood and Spelke 2005). In the current study, there was an analysis of whether gender is a factor in numeracy performance in the second grade.

Aunio and Niemivirta, (2010) conducted a study titled Gaining options: A mathematics program for potentially talented at-risk adolescent girls in America. The findings were that gender differences in mathematics achievement are either diminishing or practically non-existent; other contemporary researchers have found that gender differences in the mathematics confidence of American students may still be prevalent. Little research has been conducted internationally into

strategy differences in solving mathematics problems by girls and boys at primary school level. In Zambia, particularly Lusaka District, it was not known whether or not this was the case.

Fennema, Carpenter, Jacobs, Franke, and Levi (1998) carried out a study titled Teachers' attributions and beliefs about girls, boys, and mathematics in Kenyan schools and the purpose was to investigate the factors to 'poor performance in mathematics. The study exploited where 44 boys and 38 girls were interviewed a total of five times over a period of three years (grade 1 to grade 3). They used one method of data collection which was an interviews under longitudinal study findings were that clear strategy differences in a longitudinal study Compared to the boys, the girls counted more often and used materials more often. The findings were that the boys on the other hand used abstract strategies that showed a higher level of understanding more often. At the end of grade 3, the girls used standard algorithms more often. A positive connection between being able to create their own approaches in the lower grades and being able to solve complex problems in grade 3 existed for both boys and girls.

The outcome of the above study have shown that there was a positive connection between being able to create their own approaches in the lower grades and being able to solve complex problems in grade 3 existed for both boys and girls. However, Fennema, et al (1998)'s study is differs to the current study in that it focused on the numeracy levels of the second grade in Zambia. Furthermore, the current study exploited where 126 boys and 126 girls were the participants and the second grade in particular under quasi-experimental design making it quantitative in nature as opposed to the Kenyan study which was qualitative.

Trying to find out what causes gender inequity in mathematics education has been the centre of attention of much gender research (Kaino, 1998) Bordo, 2001; Costello 1991). These studies have resulted in an extensive but incoherent body of information suggesting why females in developing world are underperforming in some areas of mathematics education especially in sub-Saharan Africa. Such beliefs as "Females are not good in mathematics still have their advocates because of long-held assumptions and beliefs. However, there is consistent documentation that the major contributors to the gender gap in mathematics are environmental in nature influenced by society (Braumiller, (2008). The stimulation of executive functions to learners at an early stage can break all the barriers hence the study. (Miyake et al (2000).

The study done in London by Burton (1996) found that girls outperformed boys in Mathematics in both urban and rural areas. Another study done by Kaino (1996) in Swaziland established that girls can do even better than boys in mathematics. The above findings on performance of girls in mathematics shows that girls are not generally poor performers in mathematics and that they are capable of getting higher grades.

Adams and Hitch (1997) conducted a study entitled Working memory: Implications for individual differences in mathematics development on relationship in children aged 8 to 11 years using simple mental addition ( $5 + 2$ ) and complex mental addition ( $523 + 26$ ) problems. It was revealed that resolving problems presented verbally was associated with high working memory. Whereas solving problems presented visually was connected too little working memory. In addition, they also established that the level of problem difficulty was related with working memory contributions, with higher working memory spans conforming to higher difficulty problems (Braunmiller, 2008). While the aforesaid study invoked as study by involving children aged 8-11 on simple mental addition ( $5 + 2$ ) and complex mental addition ( $523 + 26$ ) problems.

In a longitudinal study conducted by Aunio and Niemivirta (2010) on how children's early numeracy evaluated in kindergarten predicts their mathematical performance in the first grade, after controlling for the effects of age, gender and parents' education. They establish that the attainment of counting and relational skills before formal schooling are projective of the attainment of elementary mathematical skills and generally mathematical depiction in grade one on the effects of demographic factors.

From the above studies, it had been observed that children's early numeracy evaluated in kindergarten predicted their mathematical performance in their first grade, after monitoring for the age, gender and parents' education. It further, highlighted the attainment of counting and relational skills before formal schooling were projective of the attainment of elementary mathematical skills and generally in grade one. While the foresaid studies established this empirical evidence among the pre-grade in kindergarten.

A number of studies revealed that in an educational era that emphasizes problem solving and meaningful instruction has been a significant increase in the number of tasks that require students to plan, initiate, organize, prioritize, shift, and check their work. These executive function

processes are particularly important for effective learning in math. Learners need to come to class ready, complete and pass in homework, take organized notes, study efficiently, and perform well on tests. (Anderson, 2008; Garthecole et al., Swanson Beebe-Frankenberger, 2004; Letho, 1995; and Mwanza- Kabaghe, 2015). What is not known is how executive function influences numeracy attainment especially in the second grade level hence the study.

A study by Mazzocco and Myers, (2003) on children lack of numeracy skills and approaches as well as the inspiration and confidence in Australian schools revealed that providing learners with systematic and strategic instruction and teaching them how to utilize spaces successfully are important to empower them through the math program. This is because executive functioning involves numeric attainment which is associated with working memory system in that they require the storage of information while execution other mental operations. A justification for the current study.

A study done by Bull Scerif (2001) focused on children's numerical skills in relation to executive function in Columbia, the findings were that learners with problems in inhibition and working memory often result in problems in shifting, monitoring, and approximating plans for a given task. This implies that in order to learn numeracy and perform well in tests, learners require to attend, self-monitor, self-reflect, and self-regulate, and these actions are often compromised when there is an associated with numeracy learning. While the above study focused on children's numerical skills in relation to executive function in Columbia, it did not specify the grade level as opposed to the current study which specifically looked at the second grade in Zambia.

Female children often have an advantage on measures of general intelligence, possibly related to earlier maturation of the female brain (Holloway, 1998). Additionally, girls show early advantages in reading comprehension an ability that has been linked to executive function skills (Miller and Mercer, 1997). Sex differences on executive function tasks are less consistent, but often do favor girls.

Mileva-Seitz, et al (2015) conducted a study entitled are boys more sensitive to sensitivity? Parenting and executive function in preschoolers. The findings were that 4-year-old girls outperform boys on tests of inhibitory control as measured by the Go/No Go task. The aforesaid study had revealed that 4-year-old girls outperform boys on tests of inhibitory control as measured by the Go/No Go task.

Additionally, Andersson, (2010) performed a longitudinal investigation of adolescents' executive function skills and concluded that females show evidence of mature inhibitory control by the beginning of adolescence, while males do not. Contrary Andersson, (2010) did not find any sex differences in accuracy of inhibitory control in their sample of 5-to 8-year-olds. While some researchers have found sex differences in some researchers have found sex differences in working memory as well.

Throughout the component analysis of answers from 6758 Swedish students it was found that there were some differences in how boys and girls perceive their classroom setting. According to the classroom setting, the study found that boys feel that they use group work more than the girls do. Boys also feel that they have an influence over the content and are more involved during the lesson than girls. With respect to students' relations to mathematics the study revealed that boys perceive mathematics to be more important than girls do. One implication for teachers from the study points out how different aspects of a perceived learning environment affect students', boys' and girls', achievement in numeracy.

The findings of the above studies were conducted among Swedish students the question that begs the answer is whether or not this can be the case for Zambian children.

### **2.2.1. Association between numeracy and EF**

Many studies have found associations between executive functions and Numeracy Skills, However, results are still inconclusive, as other studies did not find some of these associations especially associations considering the executive functions against numeracy, inhibition and shifting which are not always found (Censabella and No'el, 2008 and Mwanza-Kabaghe, (2015).

Baddely (1996) in his multi-component model reported that executive functions are strongly associated with the numerical abilities in children. This implies that executive functions work concurrently with memory tasks such as displaying the harmonization and monitoring of simultaneous processing and storage of information which are significant throughout the performance of numeracy and mathematical tasks. In as much as executive functions was associated with numerical abilities in children, it was not known whether the case is the same with the second grade learners.

Mwanza-Kabaghe (2015) conducted a study titled pre-school, executive functions and oral language as predictors of literacy and numeracy skills in first grade in Zambia. The study exploited 216 learners where 45% were boys and 55% girls. The purpose was to establish whether preschool promotes Executive functions which later promotes literacy and numeracy skills in the first grade. The study was quantitative in nature and employed a quasi-experimental design. The results of the study indicated that there was a positive association between executive functioning in numeracy than literacy and that pupils who went to preschool did not outperform pupils who did not go to preschool in first grade. Furthermore, the study revealed that executive functions, did predict literacy and numeracy skills particularly working memory and inhibitory control predicted literacy and numeracy skills over and above other executive functions.

The current study had a lot to learn from the aforementioned study in that both studies employed quasi-experimental design and are about quantitative. It was however, important that the current study be conducted as it took a new dimension of determining the role of executive function in numeracy attainment in the second grade by ignoring other predictors such as oral language and literacy as treated in the Kabaghe' study.

A study by Anghel (2010) looked at executive function in preschool children and working memory predicting numerical ability at school age. The findings revealed that EF predictions are intensely correlated with children's numerical skills because executive processes of memory, organization, flexibility, arranging and control are important in numerical success; this is so because EF changes words into numerical reason thereby offering pertinent information and keep the words and numbers in WM. The above information is vital to the current study as it provides a platform of measuring the role of executive function in numeracy attainment among second graders and not pre-school children.

Additional, a study conducted by Clark et al. (2013) specified that children's inhibitory control and working memory at age three predicted their early math attainment two years later, after controlling for their prior informal math skills. This gave a researcher an impetus to determine the role of executive function skills in numeracy attainment in the second grade.

Another study by Kroesbergen et al. (2009) which examined how basic cognitive procedures were associated to numeracy capabilities to regulate which children are at risk for developing math

disabilities. Different elementary procedures in the growth of mathematics was examined, which is executive functions. The results revealed that both executive functions and numeracy were imperative factors in children's growth of counting skills. A very important finding to the current study as it shows the importance of EF in numeracy.

McClelland, (2007) conducted a study to examine predictive relations between preschoolers' behavioural regulation and emergent literacy, vocabulary and math skills. The study showed that behavioural regulation significantly and positively predicted fall and spring developing numeracy skills on the Woodcock Johnson Tests of Achievement. Furthermore, development in behavioural instruction predicted growth in developing literacy, math skills over the pre-kindergarten year, after controlling for site, child gender and other background variables. The current study was different from the aforementioned study as it considered second grade level in numeracy as opposed to pre-school and first grade learners in literacy, vocabulary and numeracy. It however, informed this study as it is one of the few studies that used Behavior Regulation (BR) and not EF making the researcher curious to find out the differences between EF and BR which turned out to mean one and the same thing.

Furthermore, Alloway and Passolunghi (2010) established the involvement of working memory and mathematical skills in children. A sample of 206 seven- and eight-year-olds was administered tests of these cognitive skills. A different pattern developed that was reliant on both the memory task and the math skill. In the seven-year olds, visual-spatial and verbal memory exclusively associated its performance on the math tests; however, in the eight-year olds, only visual-spatial short-term memory associated math scores, memory skills exceptionally associated mathematical skills and arithmetical abilities.

Espy, McDiarmid, Cwik, Stalets, Hamby, and Stern, (2004) examined the support of executive functions to developing numerical skills in primary children. The children's total number 96 completed an executive function battery that had empirically concentrated working memory, inhibitory control and shifting capabilities by computing complex scores resulting from standard element analysis. Both working memory and inhibitory control predicted early arithmetic ability. The experimental associations remained strong even after controlling statistically for age.

Espy, (1997) conducted a study titled skills underlying mathematics: the role of Executive functions in the development of mathematics proficiency in United Kingdom on preschooler and young school-age children in France, the study revealed that relationship between EF and academic attainment is less clear. In addition to working memory, inhibition as well as cognitive flexibility are closely linked with performance on pre-math suggesting that in contrast to findings in school-aged children, the three EF components are of equal importance in early childhood. Similarly a study by Mwanza-Kabaghe (2015) in Zambia found that working memory and inhibitory control predicted math performance in first grade.

Findings of Des melt et al (2009) suggest a stronger association between EF and numeracy skills while Best and Miller (2011) did not agree with the association, instead advocate for a domain-general association between EF and academic attainment. One explanation for the discrepancies in the literature could be the differences in EF tasks used. Additionally, it appears that EF are more closely linked to certain aspects of academic skills such as numeracy and useful problems. Hence there was need to carry out an independent study which could possibly fall in favour of Des melt et al (2009); Best and Miller (2011).

Studies that related these executive functions to numeracy found a relationship between math's and updating almost consistently but results regarding shifting and inhibition are less clear, with some studies finding a relationships between tasks measuring inhibition and shifting abilities while others did not or only partially support these findings (Censabella and No"el, 2008; Espy et al. 2004; Lee et al., 2013. With these conflict results therefore, there was need to set records straight by determining the role of executive function in numeracy attainment in second grade.

### **2.3 Guardian/care givers of participants**

Carlson, (2009) conducted a study titled "Marriage and the Public Good: Ten Principles; why Marriage Matters on children aged 3 to 10 in South Africa and its purpose was to review the family factors contributing to individual differences in early executive functions which has remained scarce. It also analyzed the importance of social interactions in the development of executive functions, suggesting relationships with caregivers provide the opportunities and support needed for these developing skills. The findings indicated that Children raised in intact married families are more likely to attend college, are physically and emotionally healthier, are less likely

to be physically or sexually abused, less likely to use drugs or alcohol and to commit delinquent behaviors, have a decreased risk of divorcing when they get married, are less likely to become pregnant/impregnate someone as a teenager, and are less likely to be raised in poverty.

The study further revealed that Children receive gender specific support from having a mother and a father. Research shows that particular roles of mothers (e.g., to nurture) and fathers (e.g., to discipline), as well as complex biologically rooted interactions, are important for the development of boys and girls. The findings indicated that a child living with a single mother is 14 times more likely to suffer serious physical abuse than is a child living with married biological parents. A child whose mother cohabits with a man other than the child's father is 33 times more likely to suffer serious physical child abuse.

The above study is insightful in that it highlighted the importance of both parents to children I having better executive functioning and the benefits of children growing in family of both mother and father. However, while the reviewed study focused of the importance of children coming from both parents from 3 to 10 years in South Africa, the current study focused on the establishing whether or not guardian/care giver affects performance in executive functioning and numeracy in the second grade in Lusaka District.

Another important aspect from Carlson, (2009), s study the finding that paternal parenting quality may be particularly influential in toddlerhood, as opposed to earlier in development. As noted by Carlson (2009), parenting practices may have varying effects on executive functions depending on the age and emerging abilities of the child. Although some basic components of executive functions emerge in infancy, the substantial growth in executive functioning skills across toddlerhood may offer an important window for parental influences). Further, evidence suggests fathers may be more involved in the toddler years than during infancy.

Similarly, Bernier et al., 2012 carried out a study on executive functioning and parental support in Cameroon. The findings clearly showed the advantages when children are raised by two married parents. This does not diminish the exemplary efforts of many single parents, whose "courage and determination young children are totally dependent on nurturance from parents or other care giver.

Bernier et al., (2012)'s study has shown the importance of parental support with respect to global development of the child. It also noted that single parents were also important to children but Parenting is demanding because meeting the needs of children, let alone maximizing their potential requires personal, social and economic resources. Therefore, the current study differs from Bernier et al., (2012)'s study as it specifically focused on the benefits of children with both parents and executive functioning.

## **2.4 Summary**

The chapter presented literature related to this study in line with the themes derived from research objectives. It has informed and shaped the study as it has allowed the researcher to interact with different existing literatures pertaining to the role of executive functioning in numeracy attainment in the second- grade. However, it appears no clear documentation of information has been done on the role of executive function in early numeracy attainment in the second grade in Zambia.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.0 Overview**

The previous chapter presented literature related to this study in line with the research objectives. This chapter outlines the methodology used to collect data in this study. This comprises a research design, population, sample size, sampling technique, instruments for data collection, validity and reliability and sampling procedures. Further, it covers data analysis as well as ethical considerations utilized in this study.

#### **3.1 Research design**

According to Yawson (2009:36) a research design is “the overall plan for collecting data in order to answer research questions.” It also involves specific data analysis techniques or methods the researcher intends to use. Similarly, Bellany and Perry (2012:14) hold a clearer and more vibrant view as they define a research design as “a requirement of the way in which data will be created, collected, constructed, coded, analyzed and interpreted in order to enable the researcher draw justified descriptive, explanatory or interpretive inferences.”

This study was quantitative in nature and utilized a quasi-experimental design with the view of comparing school going children from low, medium and high density school settings. Quasi-experimental design was selected and used because of its power to quantify over variables which can be generalized in terms of amount, intensity and frequency with the intention of explaining, describing and making empirical conclusions from obtained results (Creswell, 2009). This implies that quasi-experimental design falls under a quantitative paradigm which makes it possible to control for prediction of variables (White, 2005). In this way, quantitative research is usually embedded and anchored on the side of the positivist philosophers who assume that reality is arrived at through science (experiments) which can be explained, controlled and predicted by nature. Therefore, the selection of this research design enabled the researcher to compare school going children from low, medium and high density in the school setting in tandem with the role of executive function in numeracy attainment in the second grade in Lusaka, Zambia.

### 3.2 Study Sites

The study was conducted in Lusaka District at six primary Schools. This is because Lusaka District has the type of schools that the researcher targeted, which included low, medium and high-density schools.

### 3.3 Study population

A population as defined by White (2005) as the universe of units from which a study sample is Selected. Kombo and Tromp (2014) states that a population consist of individuals, elements or objects of specific group with common characteristics to which the researcher plans to generalize the results. Grade 2 pupils from six selected primary schools from Lusaka districts in Lusaka Province of Zambia were targeted in this study. Grade 2 teachers of the selected children were also involved in the study just to provide information which became part of pupils' data. This population gave adequate information needed for the study because the targeted population has the necessary knowledge and experience.

### 3.4 Study Sample

A sample by definition is a number of individuals or objects from a population, containing elements representative of the characteristics found in the entire group (Orodho and Kombo, 2002). Kombo and Tromp (2006) defines a sample as a subset of a population or the segment of population that is selected for investigation.

**Table 3.1: Age distribution by gender and location of school**

<b>Gender</b>	<b>Girls</b>	<b>126</b>	<b>50%</b>
	<b>Boys</b>	<b>126</b>	<b>50%</b>
<b>Age</b>	7	44	17.5%
	8	126	50%
	9	44	17.5%
	10	38	15.1%
<b>Location of school</b>	Low Density	90	35.7%
	Medium Density	82	32.5%
	High Density	80	31.7%

(Source: Field work, 2016)

A total of 252 (126 boys and 126 girls) second-grade children were selected and recruited for the study from the 6 primary schools of which two (2) were low Density areas 90 ( 35.7%), two (2)

from medium Density area 82 (32.5%) and two (2) from high density areas 80 (31.7%). In Zambia setup the 'so called low density 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. The age of the participants with 7 years were 44 (17.5%); 8 years 126 (50%); 9 years 44 (17.5%) and 10 years 38 (15.1%). The least were those aged 10 years old representing 38 (15.1%) of the total participants. The mean age of these pupils was 8.3 years.

All six 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 General Education. According to these guidelines, assessment of children in the second grade was to be done once per term. This means that the study target group had been assessed two 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. The study sample comprised children enrolled in second grade and their numeracy skills were assessed towards the end of second grade. There were 252 children (126 girls and 126 boys).

### **3.4.1 Participants caregivers and guardians**

In order to understand that executive functions are vital for obtaining numeracy skills, data was collected from the participants with regard to who they lived with. This data was essential in establishing whether the persons the participants lived with had any effect on the executive functions.

**Table 3.2: Participant’s caregivers and guardians**

Care giver/Guardian	Total number of participants	Girls	Boys
Fathers only	26 (10.3%)	10 (3.96%)	16 (6.3%)
Mothers only	48 (19.0%)	35 (14.0%)	13 (5.2%)
Both parents	58 (23.0%)	26 (10.3%)	32 (12.7%)
Grandparents	28 (11.1%)	16 (6.3%)	12 (4.8%)
Brothers/Sisters	26 (10.3)	17 (6.7%)	9 (3.6%)
Others Relatives	66 (26.2%)	24 (9.5%)	42 (16.7%)

(Source: Field work, 2016)

Each of the participating children presented their prominent caregiver/ guardian. Of these 66 (26.2%) lived with other relatives/friends, 24(9.5%) were girls while 42(27.7%) were boys. However, 58 (23.0%) of them lived with both parents were 26(10.3%) girls and 32(12.7%) boys. The table further shows that 48 (19.0%) of the participants lived with their mothers 35(14.0 %) were girls and 13(5.2%) were boys. The general finding is that more females than males lived with their mothers only, 20 (7.9%) and other relatives, 36 (14.3%) respectively than their male counterparts.

### **3.5 Sampling techniques**

Sampling procedure is the process a researcher uses to gather people, places or things to study (Kombo and Tromp, 2014). It is also an important step in the research process because it helps to inform the quality of inferences made by the researcher that stem from the underlying findings (Thus, two sampling procedures were used in this study. These were purposive sampling and simple random sampling procedures.

Simple random sampling procedure were employed in selecting the participating schools. This type of sampling is also known as chance sampling or probability sampling where each one of the every items in the population has an equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe has the same probability of being selected (Kombo and tromp, 2014). In this study three location of schools were identified being low, medium and high density. Schools found in low, medium and high density were put in a vessel and randomly picked two from each location. This was done to enable every school in Lusaka town an equal chance of being selected. Random sampling was used in the selection of children at classroom level.

### 3.6 Instruments for Data collection

Data collection instruments are tools/methods that help the researcher to collect essential information from participants (Kasonde-Ng'andu, 2013). In order to collect the necessary data for the study, hands on tests such as a mathematics Battery tests and DLE were given to pupils. A Behavioral Rating Inventory for executive function (BRIEF), was given to teachers to fill in for each child for they knew their pupils due to every day school interactions.

#### 3.6.1 Behavioral Rating Inventory for Executive Functions (BRIEF)

BRIEF questionnaire was used to gather evidence about normal behavior related through precise spheres of executive functions. Teachers informed the researcher the difficulties learners had with different categories of performance concerning each of the spheres. The BRIEF questionnaire had sixty categories of executive skills with Cronbach's alpha scales presented in table 3

**Table 3.4: Cronbach alpha reliability scales**

<i>Skill Category</i>	<i>Number of items</i>	<i>Cronbach alpha</i>
<i>Inhibition</i>	16	.930
<i>Shifting</i>	10	.828
<i>Emotional control</i>	10	.768
<i>Working memory</i>	17	.845
<i>Plan and organization</i>	10	.813
<i>Brief Total</i>	<b>63</b>	<b>.936</b>

(Source: Field work, 2016)

The Behavior Rating Inventory of Executive Functions (BRIEF) measured the child's executive behavior that included: inhibition, shift, emotional, emotional control, working memory and planning and organization. These skills are significant in regulating learning and performance of the child in academic skills. The child's teacher filled in the BRIEF questionnaire for their pupils.

The BRIEF also depicts everyday child behavior associated with specific tasks of executive functions. The BRIEF questionnaire uses scales to measure the extent to which the respondent who is a learner behaves. The following were the sub-scales of the BRIEF.

### **3.6.2 Inhibition measurement**

The inhibition scale measured the learner's inhibitory control and suddenness, which is the child's skill to struggle desires and the skill to halt one's own desired behavior and concentrated on the given task at the suitable period. Learners with inhibitory control problems frequently require an advanced step of exterior construction to edge their thoughtless answering (Cronbach's alpha for this task = .930, n= 16).

### **3.6.3 Shift measurement**

The shift scale measured the learner's ability to change easily after activity to another. Important features of shifting contain the skill of variety evolutions, endure variation, problem-solve submissively, adjust or substitute devotion and change attention from one approach or subject to another (Cronbach's alpha for the task=. 828, n=10).

### **3.6.4 Emotional control measurement**

The emotional memory instrument controlled the emotional appearance and evaluated learner's ability to modify or regulate his or her emotional replies (Cronbach's alpha for the task=.768, n=10).

### **3.6.5 Working memory measurement**

The working memory measure restrained the volume to hold material in mind for the purpose of carrying out a task, encoding material, or producing areas, strategies and consecutive stages to attaining goals. Working memory is vital in carrying out multi-step events, comprehensive mental processes such as mental mathematics and track multifaceted commands. Suitable working memory is needed to withstand performance and consideration among learners (Cronbach's alpha for the task = .845, n= 17).

### **3.6.6 Planning and organization measurement**

Planning & organization measure the learner's skill to accomplish prevailing and future-oriented task stresses. It has two mechanisms, that is plan and organize. The planning section arrest the skill to forestall upcoming procedures and to established areas to grow appropriate progressive stages gaining time in order to convey ready job in setting goals to develop appropriate sequential steps

ahead of time in carrying out task while organization section is the skill to bring order to the information and main ideas when learning. (Cronbach's alpha for the task= .813, n=10).

### **3.7 Procedure for data collection**

Data collection procedure refers to the process through which data is collected from the respondents through the use of necessary instruments (Creswell, 2009). A letter of introduction was obtained from the Directorate of Research and Graduate Studies of the University of Zambia. It was presented to the District Education Board Secretary (DEBS) in order for the researcher to be permitted to carry out the research in six (6) government Primary Schools in Lusaka District. The DEBS granted the researcher permission and referred her to the Head Teachers in the selected government Primary Schools. The first step was to make an appointment with the school administrators of the six selected primary schools in Lusaka District. The second step involved distributing BRIEF questionnaires to class teachers of the participating learners to fill in for each child. 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 numeracy skills through the Mathematics Assessment Battery and DLE Mathematics. The two instruments together were administered in turns in a separate room (guidance room) where children were called one at a time. All assessments on children were conducted when all children were in school attending lessons so as to make the research as part of the normal time children spent in school. On average 25 minutes were spent administering the Mathematics Assessment Battery. A maximum of four days were spent at each school to collect data from all the forty two children.

### **3.8 Data analysis**

Data analysis is the critical examination and scrutiny of the coded data in order to make deductions, inductions and draw inferences. This activity involves uncovering underlying structures, extracting important variables, detecting any anomalies and testing any underlying assumptions (Kombo and Tromp, 2006). Furthermore, Andrienko and Andrienko (2006) delineate data analysis as being the process of computing various summaries and derived values from the given data by studying and examining data in order to generate conclusions about the phenomenon under study using some

analytic techniques. Since this study adopted a mixed-design, quantitative procedures interspersed with some qualitative procedures were used to analyze the data.

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 quantitative research lies in terms of amount, frequency and intensity with the view of explaining, describing, and making inferences from obtained results.

Data in this study was purely quantitative and was analyzed quantitatively using SPSS version 23. The variable totals were created from the raw scores to reduce the number of variables which stood self-sufficiently at the time of data collection. Then, data was scrutinized by descriptive statistics which included the Mean (M), Standard Deviation (SD), Minimum (Min.), Maximum (Max.) This was done to show the over-all performance of the learners on all variables, in addition to this, cross tabulations correlations and t-tests were also employed.

### **3.9 Ethical Considerations**

Ethical considerations relate to the dos and don'ts that researchers must observe during the research process for purposes of respecting and protecting the rights of the participants. They are regarded as confidentiality, seeking informed consent and avoiding deception. They are also considerations of what is morally right or wrong in the research process at various stages.

Thus, before data collection commenced, the researcher sought for an introductory letter from UNZA Directorate of Research and Graduate Studies (DRGS). Written permission to carry out the research was sought from the relevant department of Ministry of General Education (MoGE) as per government requirement. Teachers and learners were consulted on their willingness to take part in the study.

Ethical issues were highly considered in this study. Participants were informed about the nature and purpose of the study. Further, informed consent was sought from the participants before commencement of data collection. In addition, the respondents were informed that the information gathered was purely for academic purposes. Participants were not forced or coerced to give

information for this study and participants' views were treated with confidentiality and respect (see appendix 1 sample of a signed Consent form).

### **3.10 Summary**

This chapter looked at the research methodology that was used in this study. It was Conducted at a time when children had been in their second grade for almost one year. The researcher opted to apply this approach in order to examine the role of executive functioning in early numeracy attainment a case of selected government primary schools in Lusaka district. The study sample included children from low, medium and high density in Lusaka District.

An extensive range of standardized measures were, used to assess executive functioning and numeracy abilities as well as background factors. These measures have extensively been utilized in early studies both in national and international studies. This comprises a research design, population, sample size, sampling technique, instruments for data collection, and sampling procedures. Further, it covers data analysis as well as ethical considerations utilized in this study. The next chapter will look at presentation of research findings.

## CHAPTER FOUR

### PRESENTATION OF FINDINGS

#### 4.0 Overview

The previous chapter looked at the methodology utilized in the study. This chapter presents the findings of the study. These findings are in line with the research questions which included:

1. What are executive functioning levels among the learners in the second grade?
2. How is the performance of learners in numeracy in the second grade?
3. Is there an association between executive functions and numeracy performance in the second-grade?

To assess Executive functions, Behavioral Rating Inventory of Executive Function (BRIEF) 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, age, location of school and gender.

#### 4.1 Percentage of participants from each school type

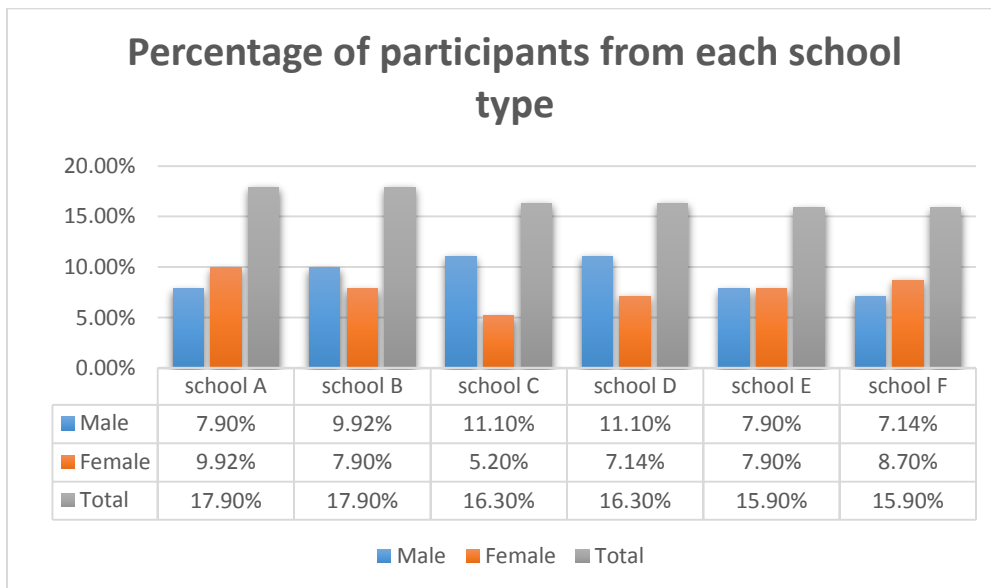


Figure 4.1 percentage of participants from each school type

(Source: Field work, 2016)

Participants came from six government primary schools in Lusaka district. From the six schools three location were identified being low, medium and high density. From school A, total respondents was 45 were 20(7.9%) were males and 25(9.9%) were females. In terms of school B, had 45 respondents were 27(10.7%) were males and females 18(7.1%). Regarding school C, total was 41 were 29(11.5%) were males and 12(4.8%) were female. As regard to school D, also was 41 respondents with 29(11.5%) males and 12(4.8%). In terms of school E and F had the total of 40 respondents each were 10(4%); 11(4.4%) were males and 30(11.9%); 29(11.5%) were females. This implies that all the gender was equally represented in the study.

#### 4.2 What are Executive functioning levels among the learners in the second-grade?

Table 3.1: Executive functioning levels among the learners in the second-grade

<b>Executive Functioning</b>	<b>Range</b>	<b>Number of learners</b>	<b>Total number of participants</b>
Inhibition	16-27	43 (17.1%)	252
	28-39	206 (31.7%)	
	40-50	3(1.2%)	
Shifting	10-15	20 (7.9%)	252
	16-20	167 (62.3%)	
	21-25	65 (25.8%)	
Emotional Control	10-15	24 (9.5%)	251
	16-20	143 (56.7%)	
	21-25	84 (33.3%)	
Working Memory	16-27	29 (11.5%)	250
	28-39	200 (79.4%)	
	40-50	21 (8.3%)	
Planning & organization	10-15	12 (4.8%)	227
	16-20	116(46%)	
	21-25	99 (39.3%)	

(Source: Field work, 2016)

In order to establish the executive functioning levels among learners in the second grade, descriptive statistics were utilized using cross tabulations. In order to understand the results, it is important to note that the statements that were used in rating the students were negative, therefore, those who scored the least are the ones with good executive functioning skills. Therefore, Table

4.1 above shows that in inhibition, 43(17.1%) learners exhibited good inhibition skills while 206(31.7%) learners showed moderate inhibition skills. Further, in shifting 20(7.9%) learners demonstrated good shifting skills while 167(62.3%) learners had moderate shifting skills. In terms of Emotional control 24(9.5%) learner showed noble emotional control while 143 exhibited moderate emotional control. On the other hand, in working memory 29(11.5%) learners performed well in working memory while 200(79.4%) learners executed fairly in working memory.

Lastly, in Planning & organization, some data points were missing, either because the child refused to participate in a particular task, or due to computer difficulties or time constraints. The number of missing values never exceeded 9.9%. Planning & organization 12(4.8%) learners achieved planning & organization skills with 116(46%) learners showing moderate skills. The study also found that the performance of the learners was moderate which implied that they were neither good nor bad.

#### 4.2.1 Inhibition with Location of schools of learners of the second grade

Table 4.2 Inhibition with Location of schools of learners of the second grade

Location of school	Inhibition range	Number of learners	Percentage	Total
Low Density schools	15 - 25	70	27.8%	90
	26 - 36	19	7.5%	
	48 - 58	01	0.4%	
Medium Density schools	15 - 25	51	20.2%	82
	26 - 36	31	12.3%	
	48 - 58	-	-	
High Density schools	15 - 25	64	25.4%	80
	26 - 36	16	6.3%	
	48 - 58	-	-	
<b>Total</b>		252	100	252

(Source: Field work, 2016)

For a learner to be rated to have good inhibition skills, one should be in the range of 15 – 25. The findings in table 4.2 above show that those learners who came from low density schools exhibited good inhibition skills translating into 70 (27.8%). Moderate ranged from 26-36 with a representation of 19 (7.5%) and severe inhibition skills ranged from 48-58 translating into 01 (0.4%).

As regard to the learners from high density schools, those with good inhibition skills ranged from 15-25 with a representation of 64 (25.4%), moderate inhibition skills ranged from 26-36 translating into 16 (6.3%).

In medium density schools, good inhibition skills ranged from 15-25 translating into 51(20.2%), moderate inhibition skills ranged from 26-36 accounting for 31(12.3%). Based on the findings of the study, it was revealed that learners from low density schools out performed learners from both medium and high density schools.

#### 4.2.2 Shifting with Location of schools of learners of the second grade

Table 4.3 Shifting with Location of schools of learners of the second grade

<b>Location of School</b>	<b>Shifting Range</b>	<b>Number of learner</b>	<b>Total</b>
Low Density	10 - 15	5 (2%)	90
	16 - 21	80(31.7%)	
	22 - 30	5(2%)	
Medium Density	10 - 15	8(3.17%)	82
	16 - 21	60(23.8%)	
	22 - 30	14(5.6%)	
High Density	10 - 15	7(2.8%)	80
	16 - 21	59(23.4%)	
	22 - 30	14(5.6%)	
<b>Total</b>	-	<b>100</b>	<b>252</b>

(Source: Field work, 2016)

It was imperative to establish the Shifting levels among learners in the second grade. In order to establish this, cross tabulations were utilized as shown in table 4.3 above, learners from medium schools in the range 10-15 showed good shifting skills accounting for 8 (3.17%), moderate shifting skills ranged from 16-21 resulting into 60 (23.8%) while those with severe shifting skills ranged from 14 (5.6%). In terms of High Density schools, learners with good shifting skills ranged from

10-15 translating into 7 (2.8%), moderate skills ranged from 16-21 accounting for 59 (23.4%) and those with poor shifting skills ranged from 22-30 translating into 14 (5.6%).

As regard to low density schools, learners with good shifting skills were 5 (2%), moderate shifting skills ranged from 16-21 representing 80 (31.7%) and those with severe shifting ranged from 22-30 translating into 5 (2%). Based on the study’s findings, it is evident that low Density schools had the least learners with severe shifting skills and good shifting skills. However, most learners in all the locations clustered in the range of 16-21 which was moderate.

#### 4.2.3 Planning and Organization with Location of schools of learners of the second grade

Table 4.4 Planning and Organization with Location of schools of learners in second grade

<b>Location of school</b>	<b>Planning &amp; Organization Range</b>	<b>Number of Learners</b>	<b>Total</b>
Low Density	10 – 15	5(2%)	90
	16 – 21	67(26.6%)	
	22 – 30	18(7.1%)	
Medium Density	10 – 15	4(1.9%)	62
	16 – 15	33(13.1%)	
	22 – 30	62(24.6%)	
High Density	10 – 15	3(1.2%)	75
	16 - 21	44(17.5%)	
	22 – 30	75(29.8%)	
<b>Total</b>	-	<b>100</b>	<b>227</b>

(Source: Field work, 2016)

It was imperative to establish the Planning and Organization levels among learners in the second grade. In order to establish this, cross tabulations were utilized as shown above. Table 4.4 shows learners from Low density with good planning and organization skills ranging from 10 -15 accounting for 5(2%). Those with moderate were 67(26.6%) and severe planning & organization ranging from 22-30 were 18(7.1%).

Further, those from medium schools with good planning & Organization skills were 4(1.9%) while those with moderate were 33(13.1%) and severe ranged from 22-30 representing 62(24.6%).

Furthermore, high density schools indicated that learners with good planning & Organization skills were 3(1.2%), moderate 44 (17.5%) and learners with severe were 75 (29.8%) The general finding in this study was that the performance was not bad as most learners were in moderate which was neither good nor bad.

#### 4.2.4 Working Memory with Location of schools of learners of the second grade

Table 4.5 Working Memory with Location of schools of learners of the second grade

Location of schools	Working memory	Number of learners	Total
Low Density	20 - 30	27(7.9%)	90
	31 - 41	63(25%)	
	42 - 52	2(0.8%)	
Medium Density	20 - 30	2(0.8%)	82
	31 - 41	2(0.8%)	
	42 - 52	80(31.7%)	
High Density schools	20 - 30	-	78
	31 - 41	14(5.6%)	
	42 - 52	64(25.4%)	
<b>Total</b>	<b>-</b>	<b>100</b>	<b>250</b>

(Source: Field work, 2016)

In order to establish the Working Memory levels among learners in the second grade, descriptive statistics was utilized using cross tabulations as indicated above. Table 4.5 shows that learners from low density schools with good working memory ranged from 20-30 translating into 27(7.9%) those with moderate working memory ranged from 31-41 resulting into 63(25%) and those with severe working memory ranged from 42-52 with a representation of 2(0.8%).

As regard to learners from High density schools, those with good Working Memory ranged from 20-30 accounting for 14(5.6%) those with moderate working memory skills ranged from 31-41 translating into 64(25.4%).

Learners from medium density schools did not perform well in working memory, This is attested to by cross tabulation results which showed that those with good working memory skills ranged

from 20-30 accounting for 14(5.6%) and those with severe skills represented 64(25.4%). In view of this, the results revealed that learners from medium schools did not perform well in working memory as compared to learners from low density schools who outperformed both high and medium density schools. The overall finding is that the performance was defendant on the location of schools.

#### 4.2.5 T test-value and Executive Function

The overall picture is that all schools performed well in individual Executive functions therefore, a t-test was carried out to determine if this difference was significant.

Table 4. 6: T test-value for the Executive Function, (Probability and statistics) Test.

<b>Variable</b>	<b>Location of school</b>	<b>mean</b>	<b>SD</b>	<b>t</b>	<b>df</b>	<b>p</b>
inhibition	Low Density	-1.70	.532	-3.204	250	.031
	Medium Density	-1.70	.532	-3.204	232.737	
	High Density	-1.70	.532	-3.204		
Shifting	Low Density	-.119	.298	-.399	250	.033
	Medium Density	-.119	.298	-.399	243.860	
	High Density	-.119	.298	-.399		
Emotional Control	Low Density	-.313	.374	-.836	249	.042
	Medium Density	-.313	.374	-.837	217.467	
	High Density	-.313	.374	-.837		
Planning & Organization	Low Density	-.798	.428	-1.862	248	.064
	Medium Density	-.798	.427	-1.868	221.163	
	High Density	-.798	.427	-1.868		
Working memory	Low Density	.934	.339	2.753	225	.039
	Medium Density	.934	.339	2.752	221.410	
	High Density	.934	.339	2.752		

(Source: Field work, 2016)

The t-test analysis for mean difference in inhibition (p= .031), shifting (p= .033), Emotional control (p= .042), Planning & organization (.064), and Working Memory (p= .039).

Children from low, medium and high density schools. From table 4.6 above established that although crosstabs found variation in performance among the schools, there was no statistically significant difference in the performance on executive functions from the three types of schools.

### 4.3 Performance of learners in numeracy in the second grade?

#### 4.3.1 Performance according to location of schools in DLE test among second grade learners.

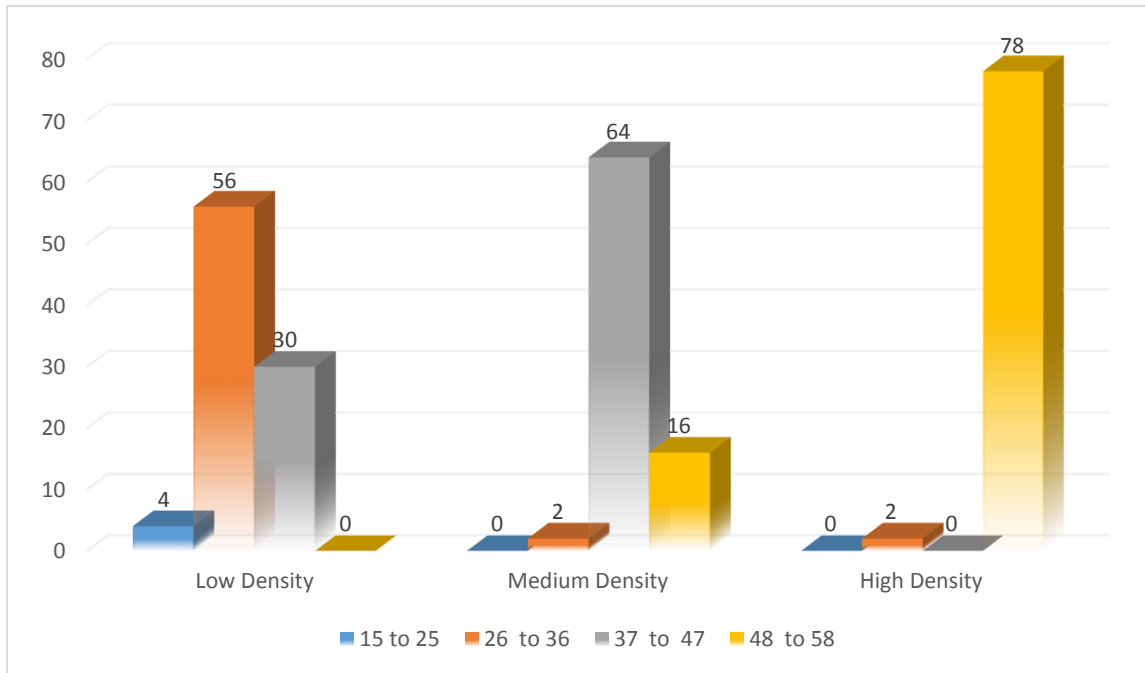


Figure 1: Figure 4.2: Performance according to location of schools in DLE test among second grade

(Source: Field work, 2016)

In order to establish the numeracy levels among the learners in the second grade, learners were exposed to DLE test which was used to collect data. The performance On DLE test in this study had a total score of 80 (100%). The marks were put in ranges to show the performance according to Location of school. A big number of learners from High density schools were in the range of 48 to 58 representing 78 (97.5%). This was followed by medium density schools whose learners scoring between 48-58 was 16 (20%) and in low density schools, learners ranged from 48-58 translating into 0 (0%).

Performance ranging from 37 to 47 was for learners from medium density schools who had a high score of 64 (80%) and Low density schools with 30 (37.5%) while high density school had no representation. The range of 26 to 36 low density schools scored the highest with 56 (70%) with both medium and high density schools scoring 2 (2.5%) respectively.

In terms low density schools, learners ranged from 15 to 25 and scored 4 (5%) while medium and high density schools had no representation. This entails that high density schools outperformed low and medium density schools whose learners were clustered in the range of 48-58 in DLE test.

#### 4.3.2 Performance according to location of schools in Mathematics Battery test among second grade learners.

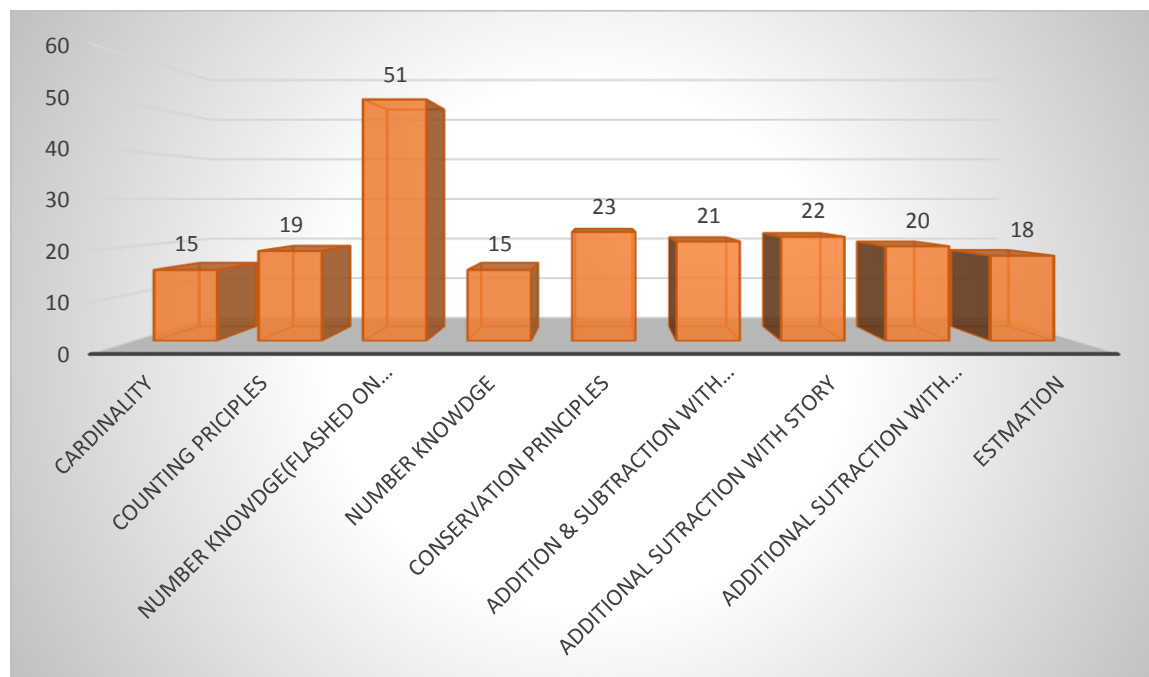


Figure 2: Figure 4.3: Performance according to location of schools in Mathematics Battery test among second grade learners. (Source Field work, 2016)

In order to establish the numeracy levels among the learners in the second grade, learners were exposed to mathematics battery test which was used to collect data. The performance in mathematics battery test in this study had different scores. Cardinality was out of 25 in which most learners scored 15 (60%); Counting principles out of 25 and learners scored 19 (76%); Number Knowledge (flashed on the screen) had the total score of 65 and learners scored 51(78.5%).

On the other hand, Number knowledge had a total score of 25 and learners scored 15 (60%). Further, in conservation principles, learners scored 23 (77%) out of 30 while Additional & subtraction with checkers which was out of 30, learners scored 21(70%), Additional & subtraction with story, learners scored 22 (73.3%) out of 30 and Additional & subtraction with Abstract, learners scored 20 (66.7%) out 30. Estimation was out of 25 and the majority of learners scored 18(72%). The general findings in this study was that the performance among learners was good in mathematics battery test.

The overall picture is that all schools performed better in numeracy, therefore, a t-test was carried out to determine if there was a difference significant.

#### 4.3.4 T test-value of DLE test and Mathematics Battery

Table 4.7 T test-value of DLE test and mathematics battery

<b>Variables</b>	<b>mean</b>	<b>SD</b>	<b>t</b>	<b>df</b>	<b>p</b>
DLE test	-13.242	1.474	-8.986	170	.146
		1.474	-9.004	169.552	
Mathematics battery	-10.001	.767	-13.242	170	.152
		.749	-13.355	142.143	

(Source: Field work, 2016)

The research question under investigation was who performed well in numeracy between children from low, medium and high density schools. From table 4.7 above the t-test analysis for mean difference in DLE test ( $p = .146$ ), mathematics battery ( $p = .152$ ) established that although crosstabs found variation in performance among the schools, there was no statistically significant difference in the performance on numeracy from the three types of schools.

### 4.3.5 Guardian / Care givers of participants with DLE test performance

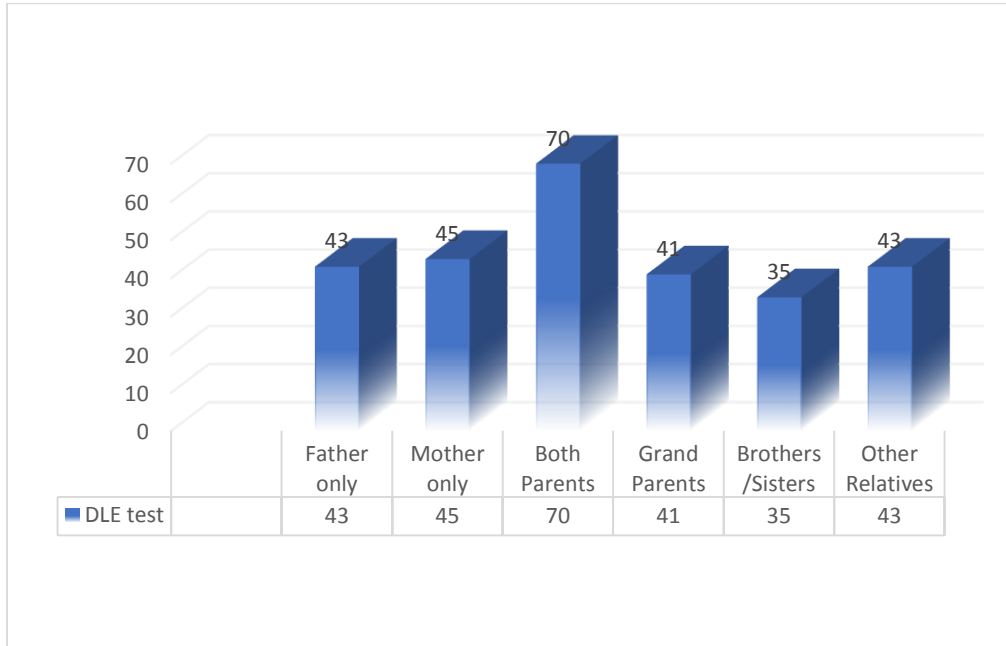


Figure 3: Figure 4.4: performance in relation to guardian/ care giver with DLE test (Source: Field work, 2016)

As evident in figure 4.4 above, participants who were coming from homes with both parents performed better in DLE test representing 70%. Those coming from homes with their mothers only represented 45%. Further, those coming from homes with their fathers only and other relatives accounted for 43% respectively while those coming from homes with their grandparents represented 41% and those that came from homes with brothers/sisters accounted for 35%. Based on the findings, learners coming from homes with both parents (Father and mother) performed better than those who came from homes with either fathers, mothers, grandparents, bothers/sisters or relative.

#### 4.4 Association between Executive function and numeracy in the second grade

Table 4.8 Bivariate Correlation between Executive function and numeracy

	1.	2	3	4	5	6	7	8	9	10
1. Age	1									
2. Gender	-.055 .383	1								
3. Inhibition	.097 .125	.199** .002	1							
4. Shifting	.066 .298	.025 .690	.075 .236	1						
5. Emotional control	.220** .000	.053 .404	.157* .013	.142* .024	1					
6. Working memory	.073 .250	.117 .064	-.018 .774	.046 .470	.100** .115	1				
7. Planning /organize	.161* .015	.181** .006	.251** .000	.033 .625	.091 .174	.114* .089	1			
8. Numeracy	.259** .000	.009 .884	.018 .781	.159* .012	.111 .078	.069 .275	.105 .114	1		
9. DLE Test	.472** .000	-.065 .305	.026 .681	.051 .419	.113* .000	.179* .210	.133* .045	.613** .000	1	
10. Location of schools	.506** .000	.126* .046	-.051 .422	.081 .200	.111 .079	.004 .954	.189** .004	.672** .000	.845** .000	1

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

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

(Source: Field work, 2016)

#### 4.5 Association between executive functions and numeracy in the second grade

Table 4.6 above displays correlations between Executive function and numeracy. From the table, age showed a positive correlations with emotional control ( $r = .22$ ) and planning & organization ( $r = .16$ ). This implies that younger children performed better in emotional control and planning & organization.

As regard to Gender it showed a positive correlation with inhibition ( $r = .20$ ), planning & organization ( $r = .18$ ). This implies that females displayed good inhibition skills than males.

As regard to shifting it positively correlated with numeracy ( $r = .16$ ). This means that it does not matter ones shifting abilities as those with poor shifting abilities seemed to perform well. Although the correlation is positive it does not support executive functions as the statements on shifting were negative meaning those who performed poorly on EF also performed well in numeracy.

In terms, of planning & organization, it negatively correlated with DLE test ( $r = -.13$ ). In view of this, the study found that those children who performed well in DLE test showed good planning & organization skills. Hence they were able to plan their work and execute it well.

Regarding DLE test and numeracy the younger children in the study performed better than the older children in the two tests. This entails that younger children performed better than order children in DLE test and numeracy.

#### **4.6 Summary of the chapter**

This chapter presented the findings of the study in line with study questions. The study found that Performance of the second grade learners in executive functioning was relatively well as seen from table 4.1 that 43(17%) children scored in the lower range which means that they have good inhibition skills as they were being rated using negative statements, The majority of the children 206(32%) scored in the moderate range. This suggests that children in the second grade have relatively good inhibition skills. The current study revealed that the majority (62 %) of children in the second grade have moderate shift skills while only 8% exhibited good shifting skills. This study did not find any connection on emotional control and performance.

In terms of numeracy the study revealed that high density schools outperformed low and medium density schools whose learners were clustered in the range of 48-58 in DLE test. Male children were order than female children, therefore, the younger were female and order were males in the study. Further, the study found that younger children performed better than order children in DLE test and numeracy and in DLE test.

Regarding association between executive functioning and numeracy the study found that males displayed good inhibition skills than females furthermore those with poor inhibition skills came

from medium and high density schools. In view of this, children who had good emotional control also had good working memory and learners who were able store and retrieve information when on demand were too able to and solve problems when found in new situations. In view of this the study found that those children who performed well in DLE test had good planning & organization skills. Hence they were able to plan their work and execute it perfectly. Furthermore, those from high density schools performed better in DLE test than low and medium density schools also those with poor planning & organization came from high density schools. This implies that learners performed better not only in DLE test but also in Numeracy.

## CHAPTER FIVE

### DISCUSSION OF THE FINDINGS

#### 5.0. Overview

The overall aim of this study was to establish the role of executive functioning among learners in the second. In finding out this it was necessary to determine the executive function levels of pupils in the second grade as well as to determine the performance of numeracy in the second. Therefore three questions were formulated. The first question was: What are the levels of executive functioning of learners in the second grade? The second question was how the was the performance of Learners in numeracy in the second grade and lastly the study sought to assess whether there is an association between executive functions and numeracy performance in the second grade.

#### 5.1 Executive Functioning Levels of Learners in Second Grade.

To establish the levels of executive functioning among leaners, the Behavioural Inventory Rating of Executive functions (BRIEF), measuring different skills such as inhibition, shifting, and updating were utilized. The study found that Performance of the second grade learners in executive functioning was relatively well as seen from table 4.1 that 43 (17%) children scored in the lower range which means that they have good inhibition skills as they were being rated using negative statements, The majority of the children 206 (32%) scored in the moderate range. This suggests that children in the second grade have relatively good inhibition skills. This is good for improvement of other executive functions as most researchers such as (Bull, Johnson, and Roy 1999; Bull and Scerif, 2001; Lethto, 1995; Lorsbach, Wilson and Reimer 1996; McLean and Hitch, 1999; Ozonoff and Jensen, 1999; Russell, Jarrold, and Henry, 1996 and Lee, 2013 agree that inhibition control is the primary executive function that precedes and allows the development of other executive functions.

In terms of shifting Miyake et al 2000 contends that shifting skills may help switching between operations, solution strategies, quantity ranges and notations between the steps of a complex multi-step problem. The current study revealed that the majority (62 %) of children in the second grade have moderate shift skills while only 8% exhibited good shifting skills. This is in agreement with Kroesbergen, Van Luit, Van Lieshout, Van Loosbroek and Van de Rijt (2009) who found that

attention shifting, is a more complex skill which involves being able to shift attention from one task to another.

Another executive function skill that was assessed in this study was emotional control on this skill 57% of the children were rated moderate while 10 % were rated as having good emotional control. A good number 33% of learners were rated as having poor emotional control. This study did not find any connection on emotional control and performance as will be discussed later, however an interesting finding concerning Emotional control was echoed by Mwanza 2011 who found that children who were poor at emotional control performed better in overcrowded classrooms than those who had Good emotional control, this claim was however, refuted in her recent work Mwanza-Kabaghe (2015), were this was not the case as those with poor emotional control also performed poorly in numeracy.

Another core EF is working memory (WM), which involves holding information in mind and mentally working with it (or said differently, working with information no longer perceptually present; Baddeley and Hitch 1994, Smith and Jonides, 1999). Regarding working memory in this study 79% of the learners were rated as having moderate working memory skills while 12% were rated as having good working memory. 5 % of learners were found to be having severe working memory. This is in line with Flock, Smalley, Kitil, Galla, Kaiser-Greenland, Locke...2010 who found that working memory had positive impact in the leaning process and increased children's performance in numeracy levels in schools. It is important for the second grade learners to have good WM in order to perform well in numeracy for it involves reasoning, and requires mentally reordering of the basis and results.

Numeracy in children requires WM, as does mentally reordering items such as reorganizing, translating instructions into action plans, incorporating new information into thinking or action plans (updating). The reasoning in the second grade learners would not be possible without WM which is critical for learner's ability to see the connections between seemingly unrelated things and to pull apart elements from an integrated whole, and creativity is involved in stripping and recombining of elements in new ways.

Planning is the ability to formulate actions in advance and to approach a task in an organized, strategic, and efficient manner (Diamond, 2011). Regarding planning and organization as core

component of executive functioning the current study revealed that the majority (46 %) of children in the second grade had moderate planning & organization skills while only 5 % exhibited good planning and organization skills and 39% children had poor planning & organization skills. The children who had good planning & Organization skills also performed well in numeracy. This is in agreement with Alloway, (2010) who found that planning & organization help children to learn at any level and utilize their full potential to enhance self-efficacy, achievement and motivation. This entails that Planning & organization skills benefit second grade children to express their action in advance. Second grade learners should be taught methodically in schools as a prequisite for writing, reading and completely projects in contents areas as numeracy.

The study also revealed that location of school had a part to play in inhibition skills. Inhibition is the ability to suppress a dominant or automatic action or thought as related to cognitive, emotional, and motor control (Best et al., 2009). Table 4.1.1 shows that inhibition skills in children from low density schools were rated better than those from medium and high density schools. The reason could be that low density schools are away from the markets, roads, bars and noise areas compared to schools from high and medium density schools. The above finding is in line with the findings by (Martin, 2000; Tharp and Gallimore, 1989) who observes that the environments in which children are found present different situations. Developmentally sensitive contexts include many everyday happenings involving physical action, play, problem solving, and exploration of materials and events.

Shifting is the ability to shift between mental states, operations, or tasks (Miyake et al., 2000). In terms of shifting skills, medium density schools had 3. 17% learners in the range 10 - 15 exhibiting good shifting skills out performing high density 2.8% and lower density skills 2%. This is because shifting is challenging to children in the primary grades especially those with learning and attention difficulties. As regards to working memory and location of schools Low density schools 27(7.9%) performed better than medium 2(0.8%), and high density schools 0(0%). In terms of schools, residential factors had an impact on WM of the second grade learners. Learners from low density schools came from privileges homes were materials and financial status was stable hence good WM skills. This study resonates with a study by Baddeley's multicomponent model theory in that working memory allows a child to hold more material for extensive period of time and psychologically rehearsal of the information so that it can be effectively merged into long term

memory. Children's abilities are noticed through performance in academic subjects at school and their participation in co-curricular activities also through play activities at home and with their friends. Therefore, it is important that learners are exposed to different child centered methodologies such as group work, role play, debate and other methodologies of cooperative in nature which are important in enhancing learners working memory abilities.

To establish whether females and males performance was better than the other a T test was conducted the study found that gender had no effect on executive functioning in the second grade. This is similar to the finding echoed by Gerstadt, Hong, & Diamond, (1994) who found that boys and girls performed equally accurately on all measures of executive function and numeracy abilities. Overall in Executive functions there was no statically significance difference among the three location.

## **5.2 Determine learners' performance in numeracy in the second grade**

To establish the levels of numeracy among leaners, DLE test and Mathematics Battery were utilized. However, the study found that the general performance in mathematics was good .This means that children did not differ in performance whether they came from Low, medium and high density schools. This may be so because in this era children are exposed to technology which require them to use cognitive thinking to execute activities.

A big number of learners from High density schools were in the range of 48 to 58 representing 78 (97.5%). This was followed by medium density schools whose learners scored 48-58 was 16 (20%) and in low density schools, learners ranged from 48-58 translating into 0 (0. This entails that high density schools outperformed low and medium density schools whose learners were clustered in the range of 48-58 in DLE test. The reason to why high density school outperformed low and medium density schools could be that learners from high density were involved in petty business after schooling hours selling various commodities such as scones, ice blocks and groundnuts to help their parents daily up keep. Hence good numeracy skills. This suggests that children in the second grade performed relatively well in numeracy.

In this study to establish the numeracy levels among the learners in the second grade, learners were also exposed to mathematics battery test which was used to collect data. The performance in mathematics battery test had different scores. Cardinality was out of 25 in which there was an

average of 15 (60%); counting principles out of 25 mean 19 (76%); Number Knowledge (flashed on the screen) had the total score of 65 with mean of 51(78.5%). On the other hand, Number knowledge had a total score of 25 with mean 15 (60%). Further, in conservation principles, learners scored a mean of 23 (77%) out of 30 while Additional & subtraction with checkers which was out of 30, learners had an average 21(70%), Additional & subtraction with story, most learners scored 22 (73.3%) out of 30 and Additional & subtraction with Abstract, learners scored 20 (66.7%) out 30. Estimation was out of 25 and the majority of learners scored 18(72%). The general findings in this study was that the performance among learners was good in mathematics battery test.

This is in agreement with a study conducted by Wood and Spelke, (2005) who observed that learners' performance in numeracy skills was moderately good and that children exhibited some characteristic of numeracy skills such as the competency to recognize differences in level which can be progressed by teaching.

Similarly, the finding is in resonance with Perry and Docket (2008) who recommended that learners should be exposed to truly challenging tasks so that numerical sense making is practiced. This implies that when teaching through problem solving, learning takes place during the process of attempting to solve problems in which relevant mathematics concepts and skills are embedded. A similar finding was echoed by Miller and Mercer (1997), who reveals that numerical problems that are truly problematic and involved significant mathematics have the potential to provide the intellectual contexts for learners 'numerical development. Numerical concept formation is believed to involve an active process on the part of the learner and building 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 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 (Aunio and Niemivirta , 2010). At this stage, the play technique, should be the use of songs and rhymes which are useful ways of presenting numerical concepts in a relaxed and enjoyable manner.

Through sand play, water play, art craft 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 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 anticipated children's performance in numeracy not to be low. Teachers too are expected to teach numeracy 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 (Bull and Scerif 2001).

The use of counting to determine exact quantities is considered to be another fundamental enumeration ability (Mazzoco and Myers, 2003). 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 (McLean and Hitch 1999; Miller and Mercer 1997; Perry and Dockett 2008; Aunio and Niemivita 2010), as research has indicated that counting is an important precursor of later math abilities.

### **5.3 Guardian/Caregiver of participants**

In terms of guardian/care giver of the participants the study revealed that participants who were coming from homes with both parents performed better in DLE test representing 70%. As evident in figure 4.4. This is in line with a study by Caston (2009) who found that children raised in intact married families are more likely to attend college, are physically and emotionally healthier, are less likely to be physically or sexually abused, less likely to use drugs or alcohol and to commit

delinquent behaviors, have a decreased risk of divorcing when they get married, are less likely to become pregnant/impregnate someone as a teenager, and are less likely to be raised in poverty. This implies that both parents play a vital role in children's development of executive functioning and numeracy. Parents should be encouraged to live as a married couple for they play pivotal roles in children holistic wellbeing. Research shows that particular roles of mothers (e.g., to nurture) and fathers (e.g., to discipline), as well as complex biologically rooted interactions, are important for the development of boys and girls.

The study revealed that children who came from homes with mothers only represented 45%. Children receive gender specific support from having a mother and a father. ("Marriage and the Public Good: Ten Principles," (2006). A child living with a single mother is 14 times more likely to suffer serious physical abuse than is a child living with married biological parents. A child whose mother cohabits with a man other than the child's father is 33 times more likely to suffer serious physical child abuse.

Although paternal and maternal contributions to executive functioning have yet to be examined separately, there is a strong theoretical and empirical rationale for considering the unique impact of fathers' parenting. Consistent with a family systems perspective (Cox and Paley, 1997), child development is inextricably embedded within a network of family relationships, with both mothers and fathers providing independent and interrelated influences. Indeed, evidence suggests fathers' parenting quality has a distinct and important role in early cognitive development and regulatory skills, even after maternal parenting quality is taken into account.

Within the current sample, evidence has been found for fathers' unique contribution to children's general cognitive development across the first 3 years of life, accounting for maternal contributions (Mills-Koonce et al., 2014). As noted by Grossman and colleagues (Grossmann, Fremmer-Bombik, Kindler, & Scheuerer-Englisch, 2002).

#### **5.4 Association between executive functioning and numeracy**

Concerning the associations between EF and numeracy skills, some studies have been carried out in young children. They found that the observed associations can partly be explained by intelligence, socioeconomic status (SES), social network support and socio-affective functioning as well as socio-demographic characteristics (Bull, Espy, Wiebe, Sheffield, and Nelson, 2011;

Clark et al, 2010; Monette, Bigras, and Guay, 2011; Navarro et al., 2012). Although there are few studies reporting significant effects, the above results underscore the need to examine them carefully.

The current study, intended to establish whether or not there was an association between executive functioning and numeracy performance in the second grade. The findings in this study did not show an associations between the overall executive functioning but (individually) and numeracy in the second grade. This is contrary to the findings of Mwanza-Kabaghe (2015) in Zambia who found that there was a positive association between overall executive functioning in numeracy than literacy. Furthermore, her study revealed that executive functioning did predict literacy and numeracy skills particularly working memory and inhibitory control.

The study found that age showed a positive correlations with emotional control and planning & organization. Implying that younger children performed better in emotional control and planning & organization. With regard to Gender the study found that females displayed good inhibition skills than males. This contrary with studies conducted by Clark et al., (2013) who found that British older children performed better in planning & organization, emotional control and inhibition compared to young British children.

As regards to shifting it positively correlated with numeracy ( $r = .16$ ). This means that it does not matter ones shifting abilities as those with poor shifting abilities seemed to perform well. Although the correlation was positive it does not support executive functions as the statements on shifting were negative meaning those who performed poorly on EF also performed well in numeracy.

In terms, of planning & organization, it negatively correlated with DLE test ( $r = -.13$ ). In view of this, the study found that those children who performed well in DLE test showed good planning & organization skills. Hence they were able to plan their work and execute it well. This is in agreement with Braunmiller, (2008) who found that children that had abilities to shift their mindset showed good planning & organization skills and performed well in mathematics.

Baddeley's multi-component model was engaged in this study to examine the interrelationships between executive functions and numeracy. It was anticipated that children who are able to control their behaviour during chores are able do better in numeracy skills (McClelland, 2007). The question which begged answers was whether Baddeley's multi-component model was the

paramount theory to measure the association between executive functions and numeracy. The results in this study were expressively correlated, thus in agreement with the multi-component model (Baddeley, 1986; 2000). The findings are in line with aforementioned studies which confirmed the strength of executive functions and numeracy skills (McClelland *et al.*, 2006; Van der Sluis, de Jong, & Van der Leij, 2007)

## **5.5 Summary of the chapter**

This chapter presented the discussion of the findings in line with the objectives. The study found that performance of the learners was moderate implying that they were neither good nor bad. In inhibition with location of schools of the second grade the study revealed that learners from low density schools out performed learners from both medium and high density. Shifting skills and Planning & Organization showed that most learners in all locations clustered in the range of 16 – 21 which was moderate. In terms of working memory the study revealed that the performance was dependant on the location. Overall in Executive functioning there was no statistically significance difference among the three (3) types of schools.

The study found that the general performance in numeracy was good implying that there was no difference in performance whether children came from Low, medium and high density schools. Furthermore, the study revealed that, learners coming from homes with both parents (Father and mother) performed better than those who came from homes with either fathers, mothers, grandparents and brothers/sisters or relatives.

As to whether there was an association between executive functions and numeracy performance in the second grade, the findings in this study did not show an associations between the overall executive functioning but (individually) and numeracy in the second grade using bivariate correlation. In terms of demographic factors such as age, gender and location of schools it was established that age and gender had no association with executive functioning.

## **CHAPTER SIX**

### **CONCLUSION AND RECOMMENDATIONS**

#### **6.0. Overview**

The previous chapter discussed the findings of the study. This chapter summaries the research findings. At this stage, it must be confirmed that this study endeavored to investigate the role of executive functioning in numeracy attainment in the second grade. However, this investigation was confined only to six selected primary government schools in Lusaka District. Furthermore, in this chapter, the conclusion is drawn on the basis of the findings of the study and thereafter some recommendations based on the study findings. Finally the chapter ends by suggesting areas for further research on the findings of the study.

The purpose of this study was to examine the role of executive functioning in early numeracy attainment in the second grade in selected government primary schools in Lusaka District. The study sought to determine executive function skills in learners in the second grade. The study also aimed at finding out learner's performance in numeracy in the second grade. Another purpose was to establish whether there was an association between executive functions and numeracy performance in the second grade.

#### **6.1. Conclusion**

In conclusion, it is evident from the study findings that the performance of the learners was moderate implying that they were neither good nor bad. In inhibition with location of schools of the second grade the study revealed that learners from low density schools out performed learners from both medium and high density schools. In terms of Shifting skills and Planning & Organization it was found that most learners in all locations clustered in the range of 16 – 21 which was moderate. In terms of working memory the study revealed that the performance was dependant on the type of school. On the other hand, overall Executive functioning showed no statistically significance difference among the three (3) types of schools.

However, the study found that the general performance in mathematics was good .This means that there was difference in performance whether children came from Low, medium and high density

schools. This may be so because in this era children are exposed to technology which require them to use cognitive thinking to execute activities.

Furthermore, the study revealed that, learners coming from homes with both parents (Father and mother) performed better than those who came from homes with either fathers, mothers, grandparents, bothers/sisters or relative.

As to whether there was an association between executive functions and numeracy performance in the second grade, the findings in this study did not show an associations between the overall executive functioning but (individually) and numeracy in the second grade using bivariate correlation.

In terms of demographic factors such as age, gender and location of schools the study established that age and gender had no association with executive functioning.

## **6.2. Recommendations**

Based on the findings above, the following key recommendations emerged:

1. Zambian Primary education should integrate executive function (working memory and planning & organization) skills in their curriculum so that these essential skills can be stimulated at elementary grades. However, the researcher recommends that teacher training in both colleges and universities must incorporate how to stimulate executive functions in children through the Ministry of General Education.
2. Since learners' career encourages performance, career guidance is necessary to help learners get a better understanding of the importance of numeracy beyond primary school.
3. Ministry of General Education must ensure that through Continuous Professional Development (CPD) teachers in primary schools are oriented on the importance of executive functioning skills in numeracy attainment in second grades so that teachers can share the experiences on the ways to enhance learners' abilities.

### **6.3 Areas for Further research**

Arising from the research findings of this study, some aspect of this study area may not have been exhausted and may need to be studied. These areas include:

1. Research into the perception of teachers on the importance of stimulation of executive functioning.
2. Future research is also needed to enhance the growth of reasoning through the use of investigative techniques in a numerical context.
3. The study using hands on executive functioning tools to establish numeracy skills in the second grade.

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**Appendix I: Consent Form**

**THE UNIVERSITY OF ZAMBIA  
DIRECTORATE OF RESEARCH AND GRADUATE STUDIES  
SCHOOL OF EDUCATION  
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY, SOCIOLOGY AND SPECIAL  
EDUCATION**

**CONSENT FORM**

Dear respondent,

**REF: REQUEST FOR CONSENT TO BE A RESEARCH RESPONDENT**

I am a student at the University of Zambia doing a Master of Education degree in Educational Psychology. I am here to request for your consent to be one of my respondents to my research on “The role of executive functioning in early numeracy attainment a case of selected government primary schools in Lusaka district”. This will help me determine executive functioning and numeracy levels from second grade learners from Low, Medium and High density schools, in learners at primary school.

Be assured that the information you will share with me will be confidential and will only be used for academic purposes.

Your consent to this request will greatly be appreciated.

Yours Faithfully,

..... (Sign)





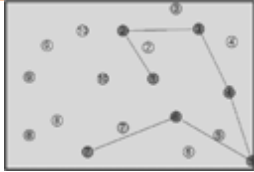



Hellen Kalumba Chalwe– Researcher/Student

**Consent by respondent**

Having read or heard the information concerning this research, I hereby voluntarily consent to be one of the respondents. In this regard, I reserve the right to end the interview at any time and choose not to answer particular questions if necessary.

Name: ..... Signature/date: .....

## Appendix II: Individual Multiple Task

Task Name	Instructions	Example items
<b>Animal stroop</b>	Name the animal body”	
<b>Local Global</b>	“Name the smaller shape”	
<b>Simon Task</b>	“If you see a mouse, press the left button, if you see a dragon, press the Right button”	 presented on right or left of computer screen) presented on right or left of Computer screen)
<b>Animal shifting</b>	“If the screen is yellow, name the fruit; If the screen is purple, name the animal”	 (varying background color)
<b>Trail making in colors</b>	“Draw a line from 1 to 2 to 3 ... , while alternating the colours.”	
<b>Sorting tasks</b>	“Draw a line from 1 to 2 to 3 ... , while alternating the colours.”	
<b>Digit span backward</b>		3 5 1 6
<b>Odd one out</b>	“Point at the shape that is different and remember its location.”	
<b>Keep track</b>	“Name each picture you see and remember the last animal.”	 (sequence of 10 successive stimuli)

### Appendix III: Mathematics Assessment Battery Scoring Sheet

#### Mathematics Assessment Battery Scoring Sheet

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

<b>cardinality</b>	1 <sup>st</sup> question: how many stars counted	2 <sup>nd</sup> question: answer of the child
Item 1		
Item 2		
Item 3		
Item 4		
Item 5		

<b>Counting till 2</b>	Write down till which number the child was able to count.	
<b>Counting principles</b>	Did kalulu count correctly? Answer of the child. 1=yes 0=No	How many stones did the child count?
<b>Item 4</b> 1-1 correspondence		
<b>Item 5</b> Abstraction pseudos error		
<b>Item 6</b> 1-1 correspondence, order irrelevant		
<b>Item 7</b> 1-1 corresponding; counting in a circle		
<b>Item 8</b> 1-1 correspondence, un ordered stones		
<b>Item 9</b> Abstraction; pseudo error		
<b>Item 10</b> 1-1 correspondence, counting in a circle		
<b>Item 11</b> 1-1 correspondence, or irrelevant: pseudo error		

<b>NUMBER KNOWLEDGE- NUMBER FLASHED ON COMPUTER SCREEN</b>	<b>ANSWER OF THE CHILD</b>	<b>CORRECT (1) / INCORRECT (0)</b>
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		

<b>NUMBER KNOWLEDGE</b>	<b>Answer of the child</b>	<b>Correct (1) / incorrect (0)</b>
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?		

<b>CONSERVATION PRINCIPLE</b>	<b>Answers of the child</b>	<b>Correct (1) / incorrect (0) correct is: without counting directly seeing that the number remains the same</b>
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)		

<b>ADDITION &amp; SUBTRACTION WITH MATERIAL</b>	<b>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.</b>	<b>Correct (1) / incorrect (0) number of stones answer of the child</b>
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)		

<b>ADDITION &amp; SUBTRACTION WITHIN STORY CONTEXT</b>	<b>Answer of the child</b>	<b>Correct (1) / incorrect (0)</b>
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)		

<b>ADDITION &amp; SUBTRACTION (ABSTRACT)</b>	<b>Answer of the child</b>	<b>Correct (1) / incorrect (0)</b>
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)		

<b>ESTIMATION</b>	<b>Answer of the child</b>	<b>Distance from the exact number of dots+/- .....</b>	<b>Within 25% of the exact number of dots 1=yes 0= no</b>
Item 25 (3 dots)			
Item 26 (8 dots)			
Item 27 (15 dots)			
Item 28 (25 dots)			
Item 29 (35 dots)			

## Appendix IV: 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.

DLE-TEST	hoofdrekenen	Teije de Vos						
TESTFORMULIER								
<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">Naam:</td> <td style="width: 20%;">Groep:</td> <td style="width: 30%;">Datum:</td> </tr> </table>			Naam:	Groep:	Datum:			
Naam:	Groep:	Datum:						
$6 + 0 =$	$6 + 4 =$	$3 + 6 =$	$2 + 10 =$					
$4 - 2 =$	$5 - 2 =$	$6 - 4 =$	$10 - 7 =$					
$3 + 2 =$	$0 + 9 =$	$2 + 8 =$	$13 + 5 =$					
$3 - 0 =$	$8 - 8 =$	$9 - 2 =$	$14 - 2 =$					
$7 + 2 =$	$4 + 5 =$	$10 + 7 =$	$11 + 7 =$					
[20]								
$20 - 8 =$	$16 - 11 =$	$20 - 15 =$	$14 - 8 =$					
$13 + 7 =$	$6 + 8 =$	$4 + 7 =$	$8 + 5 =$					
$18 - 4 =$	$14 - 13 =$	$11 - 4 =$	$16 - 9 =$					
$3 + 16 =$	$9 + 4 =$	$5 + 6 =$	$30 + 60 =$					
$18 - 12 =$	$19 - 16 =$	$13 - 7 =$	$15 - 7 =$					
[40]								
$80 + 20 =$	$73 + 5 =$	$92 + 8 =$	$47 + 4 =$					
$90 - 20 =$	$21 - 1 =$	$89 - 9 =$	$59 - 3 =$					
$40 + 4 =$	$3 + 43 =$	$27 + 5 =$	$6 + 55 =$					
$60 - 10 =$	$57 - 7 =$	$48 - 6 =$	$86 - 4 =$					
$8 + 70 =$	$57 + 3 =$	$48 + 6 =$	$9 + 63 =$					
[60]								
$4 \times 1 =$	$40 + 35 =$	$16 : 2 =$	$43 - 20 =$					
$17 + 30 =$	$14 : 2 =$	$99 - 10 =$	$8 \times 2 =$					
$8 : 2 =$	$80 - 9 =$	$7 \times 0 =$	$47 + 43 =$					
$60 - 7 =$	$5 \times 10 =$	$42 + 27 =$	$18 : 2 =$					
$6 \times 2 =$	$11 + 42 =$	$12 : 2 =$	$31 - 21 =$					
[80]								
<i>Klaar? Ga verder op de achterkant.</i>								
<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">Gemaakt:</td> <td style="width: 20%;">- Fouten, turven: (</td> <td style="width: 10%; text-align: center;">+</td> <td style="width: 10%; text-align: center;">=</td> <td style="width: 5%;">(Score)/DLE:</td> </tr> </table>				Gemaakt:	- Fouten, turven: (	+	=	(Score)/DLE:
Gemaakt:	- Fouten, turven: (	+	=	(Score)/DLE:				

# Appendix V: Behavioral Rating Inventory for Executive Functions (BRIEF)

## BRIEF-P™ Behavior Rating Inventory of Executive Function™ Preschool Version™

### RATING FORM

Gerard A. Gioia, PhD, Kimberly Andrews Espy, PhD, and Peter K. Isquith, PhD

#### Instructions to Parents and Teachers

On the following pages is a list of statements that describe young children. We would like to know if the child has had *problems* with these behaviors *during the past 6 months*. Please answer *all the items* the best that you can. Please do not skip any items. Think about the child as you read these statements and circle:

- N if the behavior is **Never** a problem
- S if the behavior is **Sometimes** a problem
- O if the behavior is **Often** a problem

For example, if having tantrums when told "No" is **never** a problem, you would circle **N** for this item:

Has tantrums when told "No"       N       S       O

If you make a mistake or want to change your answer, **DO NOT ERASE**. Instead draw an X through the answer you want to change and then circle the correct answer:

Has tantrums when told "No"       N       S       O

Before you begin answering the items, please fill in the child's name, gender, age, and birth date, as well as your name, relationship to the child, and today's date in the spaces provided at the top of the next page. If you are the child's teacher or child care provider, please check the box next to the response that best describes how well you know the child and indicate how long you have known the child in the space provided.

Additional copies available from:  
**PAR Psychological Assessment Resources, Inc.**  
10204 N. Florida Avenue • Lutz, FL 33549 • 1.800.331.8375 • www.parinc.com

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9 8 7 6 5 4 3 2 1

Revised #RO-5/04

Printed in the U.S.A.

Child's Name \_\_\_\_\_ Gender \_\_\_\_\_ Age \_\_\_\_\_ Birth Date \_\_\_\_\_  
 Your Name \_\_\_\_\_ Today's Date \_\_\_\_\_  
 Relationship to child:  Mother  Father  Teacher\*  Other\*  
 How well do you know the child?  Not Well  Moderately Well  Very Well \*Have known the child for \_\_\_\_\_ months  years.

**During the past 6 months, how often has each of the following behaviors been a problem?**

	Never	Sometimes	Often
1. Overreacts to small problems	N	S	O
2. When given two things to do, remembers only the first or last	N	S	O
3. Is unaware of how his/her behavior affects or bothers others	N	S	O
4. When instructed to clean up, puts things away in a disorganized, random way	N	S	O
5. Becomes upset with new situations	N	S	O
6. Has explosive, angry outbursts	N	S	O
7. Has trouble carrying out the actions needed to complete tasks (such as trying one puzzle piece at a time, cleaning up to earn a reward)	N	S	O
8. Does not stop laughing at funny things or events when others stop	N	S	O
9. Needs to be told to begin a task even when willing to do it	N	S	O
10. Has trouble adjusting to new people (such as babysitter, teacher, friend, or day care worker)	N	S	O

11. Becomes upset too easily	N	S	O
12. Has trouble concentrating on games, puzzles, or play activities	N	S	O
13. Has to be more closely supervised than similar playmates	N	S	O
14. When sent to get something, forgets what he/she is supposed to get	N	S	O
15. Is used by a change in plans or routine (for example, order of daily activities, adding last minute errands to schedule, change in driving route to store)	N	S	O
16. Has outbursts for little reason	N	S	O
17. Repeats the same mistakes over and over even after help is given	N	S	O
18. Acts wilder or sillier than others in groups (such as birthday parties, play group)	N	S	O
19. Cannot find clothes, shoes, toys, or books even when he/she has been given specific instructions	N	S	O
20. Takes a long time to feel comfortable in new places or situations (such as visiting distant relatives or new friends)	N	S	O

21. Mood changes frequently	N	S	O
22. Makes silly mistakes on things he/she can do	N	S	O
23. Is fidgety, restless, or squirmy	N	S	O
24. Has trouble following established routines for sleeping, eating, or play activities	N	S	O
25. Is bothered by loud noises, bright lights, or certain smells	N	S	O
26. Small events trigger big reactions	N	S	O
27. Has trouble with activities or tasks that have more than one step	N	S	O
28. Is impulsive	N	S	O
29. Has trouble thinking of a different way to solve a problem or complete an activity when stuck or new clothes)	N	S	O
30. Is disturbed by changes in the environment (such as new furniture, things in room moved around,	N	S	O

**During the past 6 months, how often has each of the following behaviors been a problem?**

	Never	Sometimes	Often
31. Angry or fearful outbursts are intense but end suddenly	N	S	O
32. Needs help from adult to stay on task	N	S	O
33. Does not notice when his/her behavior causes negative reactions	N	S	O
34. Leaves messes that others have to clean up even after instruction	N	S	O
35. Has trouble changing activities	N	S	O
36. Reacts more strongly to situations than other children	N	S	O
37. Forgets what he/she is doing in the middle of an activity	N	S	O
38. Does not realize that certain actions bother others	N	S	O
39. Gets caught up in the small details of a task or situation and misses the main idea	N	S	O
40. Has trouble "joining in" at unfamiliar social events (such as birthday parties, picnics, holiday gatherings)	N	S	O
41. Is easily overwhelmed or overstimulated by typical daily activities	N	S	O

42. Has trouble finishing tasks (such as games, puzzles, pretend play activities)	N	S	O
43. Gets out of control more than playmates	N	S	O
44. Cannot find things in room or play area even when given specific instructions	N	S	O
45. Resists change of routine, foods, places, etc.	N	S	O
46. After having a problem, will stay disappointed for a long time	N	S	O
47. Cannot stay on the same topic when talking	N	S	O
48. Talks or plays too loudly	N	S	O
49. Does not complete tasks even after given directions	N	S	O
50. Acts overwhelmed or overstimulated in crowded, busy situations (such as lots of noise, activity, or people)	N	S	O
51. Has trouble getting started on activities or tasks even after instructed	N	S	O
52. Acts too wild or out of control	N	S	O

53. Does not try as hard as his/her ability on activities	N	S	O
54. Has trouble putting the brakes on his/her actions even after being asked	N	S	O
55. Unable to finish describing an event, person, or story	N	S	O
56. Completes tasks or activities too quickly	N	S	O
57. Is unaware when he/she does well and not well	N	S	O
58. Gets easily sidetracked during activities	N	S	O
59. Has trouble remembering something, even after a brief period of time	N	S	O
60. Becomes too silly	N	S	O
61. Has a short attention span	N	S	O
62. Plays carelessly or recklessly in situations where he/she could be hurt (such as playground, swimming pool)	N	S	O
63. Is unaware when he/she performs a task right or wrong	N	S	O

Child's Name \_\_\_\_\_ Gender \_\_\_\_\_ Age \_\_\_\_\_ Birth Date \_\_\_\_\_ / \_\_\_\_ / \_\_\_\_  
 Your Name \_\_\_\_\_ Today's Date \_\_\_\_\_ / \_\_\_\_ / \_\_\_\_

Relationship to Child:  Mother  Father  Teacher\*  Other\*  
 How well do you know the child?  Not Well  Moderately Well  Very Well \*Have known the child for \_\_\_\_\_ months  years.

	Inhibit	Shift	Emotional Control	Working Memory	Plan/ Organize	
1.						1 2 3
2.						1 2 3
3.						1 2 3
4.						1 2 3
5.						1 2 3
6.						1 2 3
7.						1 2 3
8.						1 2 3
9.						1 2 3
10.						1 2 3
11.						1 2 3
12.						1 2 3
13.						1 2 3
14.						1 2 3
15.						1 2 3
16.						1 2 3
17.						1 2 3
18.						1 2 3
19.						1 2 3
20.						1 2 3
21.						1 2 3
22.						1 2 3
23.						1 2 3
24.						1 2 3
25.						1 2 3
26.						1 2 3
27.						1 2 3
28.						1 2 3
29.						1 2 3
30.						1 2 3
						Subtotal Items 1-30
						Subtotal Items 31-63
						Subtotal Items 1-30
						Total scale raw scores

	Inhibit	Shift	Emotional Control	Working Memory	Plan/ Organize	
31.						1 2 3
32.						1 2 3
33.						1 2 3
34.						1 2 3
35.						1 2 3
36.						1 2 3
37.						1 2 3
38.						1 2 3
39.						1 2 3
40.						1 2 3
41.						1 2 3
42.						1 2 3
43.						1 2 3
44.						1 2 3
45.						1 2 3
46.						1 2 3
47.						1 2 3
48.						1 2 3
49.						1 2 3
50.						1 2 3
51.						1 2 3
52.						1 2 3
53.						1 2 3
54.						1 2 3
55.						1 2 3
56.						1 2 3
57.						1 2 3
58.						1 2 3
59.						1 2 3
60.						1 2 3
61.						1 2 3
62.						1 2 3
63.						1 2 3
						Subtotal Items 31-63
						Subtotal Items 1-30
						Total scale raw scores

## Appendix VI: Ethical clearance



**THE UNIVERSITY OF ZAMBIA**  
**DIRECTORATE OF RESEARCH AND GRADUATE STUDIES**

Telephone: +260-1-290258/291777 Ext. 2208  
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E-mail: [drqs@unza.zm](mailto:drqs@unza.zm)

PO Box 32379  
Lusaka, Zambia

3<sup>rd</sup> May, 2017

Mrs. Holon Kalumba Chalwe  
Chilenga "B" Primary School  
P.O Box 30534  
LUSAKA

Dear Mrs. Chalwe,

**RE: FULL ETHICAL CLEARANCE**

With reference to your research proposal entitled: "The Role of Executive Functioning in Early Numeracy Attainment in the Second grade in selected government Primary Schools in Lusaka District," you are hereby given full ethical clearance to proceed with your research.

**ACTION:** APPROVED  
**DECISION:** 3<sup>rd</sup> May, 2017  
**EXPIRATION DATE:** 2<sup>nd</sup> May, 2018

However, it is recommended that all data to be collected should be kept confidential and that if there are plans for publication or dissemination of results, the names of the participants should not be linked with the research in order to ensure confidentiality.

Please note that you are expected to submit to the Secretariat a Progress Report and a copy of the full report on completion of the project.

Finally, and more importantly, take note that notwithstanding ethical clearance given by the HSSREC, you must also obtain authority from the Permanent Secretary of the appropriate Ministry before conducting your research.

Yours sincerely,

Prof. C. M. Namafo  
**ACTING CHAIRPERSON**  
**HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE**

cc: Director, Directorate of Research and Graduate Studies  
Acting Assistant Director, Directorate of Research and Graduate Studies  
Assistant Registrar (Research), Directorate of Research and Graduate Studies