

**DIGITAL *CHINYANJA* RHYMES, STORIES AND PHONOLOGICAL  
AWARENESS IN SOME LUSAKA PROVINCE PUBLIC PRE-  
SCHOOLS: MODERATION BY EXECUTIVE FUNCTIONS**

**By**

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I Gabriel Walubita, hereby solemnly declare that, this PhD thesis represents my own work and it has not previously been submitted for a degree, diploma or other qualification at the University of Zambia or any other university, and that it does not incorporate any published work or material from another university that has not been acknowledged.

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## **CERTIFICATE OF APPROVAL**

This thesis by Gabriel Walubita has been approved as fulfilling the requirements or partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Educational Psychology by the University of Zambia.

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## DEDICATION

To my blessed and lovely family:

my loving and caring wife, Violet Phiri-Walubita my children, the greatest miracle in my life, Thumelo, Lilato, Gabriel and Limpo. My family has given me an opportunity to learn to be a better person, and because of this, I have persisted to succeed to become a good father and husband. Lilato fascinated me with this rhyme: “My name is Kola, I love *Bola* (football), I live in *Ndola* (Zambian town), I drink Cocacola but I never *kosomola* (coughing)”. This rhyme was enough motivation to focus my study on rhymes. In addition, true to the words of Bryant and others (1989:408) "rhymes are the only measures of phonological sensitivity which one can rely on to produce above-chance level results in preschool children."

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## **ABSTRACT**

In this study, the question of whether preschool executive functions (EF) moderated the effect of a rhyme intervention on early phonological awareness (rhyme awareness) achievement has been investigated. Current understanding suggests that executive functions in older children contribute to academic achievement and school readiness. To date, however, there is little empirical evidence among young children in Zambia that support the specific role of executive functions in moderating the effect of an emergent rhyme intervention on rhyme awareness as the earliest emergent component of phonological awareness. Using a between-subjects experimental design (randomised pretest–intervention–posttest), this study explored data from 375 children aged 5 to 6 years from 14 public preschools in three districts (Kafue, Chilanga and Lusaka) in Lusaka Province. The children were randomly assigned to one of the three conditions: intervention (rhymes and stories), or the two active control conditions (action video games or free play). The EF was assessed using direct and indirect EF measures including Pencil Tap, Digit Span, Stroop and Task Orientation while rhyme awareness was tested using the rhyme production, recognition and picture rhyming tests. The first objective was to determine the performance of pre-schoolers on the named EF tests from preschool to Grade One. Second, to ascertain if EF indeed predicted rhyme awareness. The third objective was to identify the type of EF assessment approach (performance-based and/or observer reports) that strongly predicted rhyme awareness. The study found that executive functions improved from the beginning of preschool to the beginning of Grade One. On the second objective, a positive relationship between EF and rhyme awareness skills was found while on the third objective, sustained attention as assessed by task orientation, contributed a significant portion of variance in rhyme awareness skills after accounting for letter knowledge, vocabulary, age,

parental education and socioeconomic status. The study found that EF consistently moderated the effect of the relationship between rhymes, stories intervention and rhyme awareness skills. The findings of this study suggest that preschool children in public schools with adequate EF skills benefit more from rhyme awareness interventions compared to their peers with limited executive function skills. In addition, the positive relation observed between executive functions and rhyme awareness suggests that cognitive skills facilitate phonological awareness during preschool years. Future research, policy and practical implications of the current study findings are discussed in this report.

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## **LIST OF ABBREVIATIONS AND ACRONYMS**

EF	Executive Functions
AVG	Action Videogames
CLV	Chinyanja Literacy-related Videos
EF	Executive Functions
ST	Stroop Test
RAN	Rapid Automatised Naming
PTT	Pencil Tap Test
PA	Phonological Awareness
FDS	Forward Digit Span
MoE	Ministry of Education
NA	Neuropsychological Assessment
SES	Socio-Economic Status
PRP	Primary Reading Programme
PPVT	Peabody Picture Vocabulary Test
CGQ	Caregiver Questionnaire
WISC-R	Wechsler Intelligence Scale for Children- Revised

## CHAPTER ONE

### INTRODUCTION

#### 1.0 Overview

This chapter presents the background to the study by first examining the context of the study, the research problem, the purpose of the study and the research objectives. The significance of the study and finally, the theoretical framework of the study will also be discussed in this chapter.

#### 1.1 Background

Every parent and teacher wants their children or pupils to master the ability to read and write because of the many benefits that come with these skills including school success. However, not all parents and teachers know that language is crucial for literacy development in children (Moats & Foorman, 2003; Sainain et al., 2020). This thesis draws attention to the importance of preschool executive functions in supporting the connections between rhymes, stories and phonological awareness. In order to achieve this, the thesis documents how executive functions develop, their links to phonological awareness and how they are assessed.

Reading skills provide a master key to the doors of success in learning varied knowledge domains (Cunningham & Stanovich, 1997; Echols, West, Stanovich, & Zehr, 1996; Morrison, Smith, & DowEhrensberger, 1995). Failure to read could lead to the *Mathew effect* (Stanovich, 1986) which is the inability to learn other content areas (Chall, Jacobs, & Baldwin, 1990). Among the two important factors that influence reading development include phonological awareness and executive functions (Scheepers et al., 2021). Learning to read requires both the ability to recognise spoken

sounds of a language and being able to keep and process information in the mind (Cockroft et al., 2001). Both of these skills rely on cognitive as well as linguistic abilities: executive functions and phonological awareness (Santos et al., 2020).

Phonological awareness is one of the most significant indicators of early reading acquisition (Bradley & Bryant, 2013; Mann, 1986; Wolff & Gustafsson, 2022; Zugarramurdi et al., 2022) for two reasons. First, phonological difficulties are a leading cause of reading difficulties (Burns et al., 2022; Zhao & Fan, 2022) and second, phonological awareness instruction improves reading as shown in intervention studies (Dilgard et al., 2022; Nancollis et al., 2005; Partridge, 2022; Schuele & Boudreau, 2008). Because rhymes increase young children's phonological sensitivity, they should eventually, have a comparable impact on reading development (Bryant et al., 1989). The role of rhymes on reading acquisition has been argued to be the most influential because even after taking into account the children's initial phonological sensitivity, intelligence, vocabulary, and social background, rhyme awareness remains the strongest predictor of reading ability (Bryant et al., 1989, 1990; Christensen, 1997; Goswami, 1999; Goswami & Bryant, 2017).

While local research has shown that literacy interventions (Nshimbi, 2021; Jere-Folotiya et al., 2014; Ojanen, Jere-Folotiya, et al., 2015; Ojanen, Ronimus, et al., 2015; Sampa et al., 2018) are effective in improving literacy outcomes, the moderation role of executive functions towards the development of emergent literacy in preschool learners using culturally and developmentally appropriate literacy digital technology remains unclear. This study will examine local language and literacy historical developments, the role of technology in cognitive development, costs of executive dysfunction for the individual child and the nation at large, the Zambian preschool

education context and the need for a literacy and language intervention for typical preschool children.

### **1.1.1 Language and Literacy Context in Zambia**

A discussion on the role of executive functions in emergent literacy development in the Zambian preschool context is incomplete without mentioning the developments that have occurred in the area of language and literacy in Zambia since the 1900s when the first only school was established in the Western Province of Zambia. The intention for building only one school in Zambia, at the time, was purely for economic reasons (Banda & Mwanza, 2017). In the Brethren Missionary-run schools opened in Kanyonyo in 1907, the language of instruction was Silozi, one of the official local languages commonly used in this region. This local language was used in the lower primary (substandard to standard four) and English was gradually introduced as the medium of instruction in standard five (Manchisi, 2004).

In 1928, the Phelps-Stokes Commission recommended that four local languages (Cibemba, Chinyanja, Citonga and Silozi) be used as languages of instruction for the first four years of primary education. Two decades later, in 1950, the period for the use of local languages as the medium of instruction in primary school reduced from four years to only two years and thereafter, English was gradually introduced. In 1962, English became the language of instruction in the first grade of primary education at a time when the Northern Rhodesian Government was in office (Manchishi, 2004).

After Zambia became independent from British colonial rule in 1964, English was recognised as the official medium of instruction in June, 1965 and that was to be used from primary to university (Manchishi, 2004). Although, English was the language of instruction, local languages including Bemba, Kaonde, Lunda, Luvale,

Lozi, Nyanja, and Tonga were taught in schools alongside English to promote functional literacy, public education, Zambian culture and national identity (Manchisi, 2004). Although all instruction was to be conducted in English, teachers were permitted to use any of the above seven regional languages in their classroom presentations (Linehan, 2005).

Several initiatives were undertaken during the thirty years (1965-1995) that were aimed at challenging the English medium of instruction. The importance of Zambian local languages in ensuring high-quality education was highlighted in two major reviews of the educational policy in 1977 and 1991. In the 1977 education review, it was acknowledged that although learning was best done in the mother tongue, implementation of the local language as the medium of instruction was going to be difficult. This was despite widespread agreement in that learning through the medium of English was detrimental to educational achievement (Linehan, 2005). In October, 1992, Zambia responded to the 1990 World Conference on Education for All and developed the *Focus on Learning* education policy stating clearly that the local languages in education were proven beyond doubt most preferred and that, despite the administrative difficulties, the major Zambian languages would be the basic languages of education from Grades 1 to 4. The *Focus on Learning* education policy replaced the 1977 policy. Despite research showing increased poor reading levels in Zambian primary schools in both English and local languages, no attempt was made to implement this new policy until 1995.

In 1995, the Ministry of Education began to realise that it was more effective to teach children to read and write in their familiar language before moving on to a foreign language. The National Reading Committee (NRC) was established in 1995 by the Ministry of Education to boost student literacy in primary schools. Its responsibility

was to do three things: 1) get the word out about the reading crisis; 2) find reading solutions; and 3) find stakeholders that would help to address the reading crisis. In November/December 1995, the Zambia National Reading Forum was organised by the National Reading Committee. Participants at the forum identified ways of addressing the reading crisis. The following were the three recommendations proposed. First, by the end of the first year of primary education, students should be able to read and write in their home language. Second, by the end of the second year of primary education, students should be able to read and write in English and lastly, by the end of the third year of primary education, reading instruction should be improved across all grade levels through better training and more effective resources (Linehan, 2005).

In 1996, the government issued a comprehensive policy for education titled *Educating Our Future*. This policy included the Reading Forum's recommendations and stated that young learners' rudimentary skills in reading, writing, and arithmetic would be fostered through the use of a language with which they were already comfortable. This policy emphasised that while English continued to be the language of instruction, it is only fair that children be given the opportunity to learn to read and write in their familiar language. To achieve this, the Primary Reading Programme was developed by the Ministry of Education at a cost of £10.2 million (£ 1.06 per pupil) over seven years (1999-2005) as part of a larger initiative to implement the new initial literacy policy.

The Primary Reading Programme (PRP), as an intervention programme used familiar local language as the medium of literacy instruction was gradually rolled out across each of the grade levels from Grades One to Seven to address the poor literacy levels in all primary schools in Zambia. Different instructional approaches, such as look and say, whole word, whole language, and analytic method, were employed in the

Primary Reading Programme. While there were four courses that made up the Primary Reading Programme, the Primary Literacy Programme (PRP) ran from Grade 1 to 7, and included an English Oral Course and a Literacy in English as a Subject that were embedded in two policy guidelines (Chibamba et al., 2018). The New Breakthrough to Literacy (NBTL), Step into English (SITE), Pathway to English (PWTE) 1 & 2, and Read On Course (ROC) were the original four courses that made up the Primary Reading Programme. The PRP's many successes, such as students' improved reading scores that far exceeded what was typical for children of the same age in South Africa, the United Kingdom, and Ireland, were observed.

In the Breakthrough to Literacy (BTL) classrooms, there were observable signs of a fundamentally new pedagogical approach, most notably, a shift toward a more child-centered, problem-solving stance toward instruction. Despite these achievements, the PRP was not without challenges. First, implementing this programme would lead to chaos and possibly a 'tribal education system,' as all teachers would have to be assigned to areas where their native language was spoken. Second, urban children would be at a disadvantage if they had to learn a local language, since most urban children spoke English. Third, the fear that parents would oppose to their children learning the local language posed the greatest danger. Since English has historically been the language of education, public life, commerce, and, therefore, the concern that parents would view this as a step backwards was apparent. Fourth, it was impossible to find a universally agreeable language of instruction for a school's diverse pupil population (Linehan, 2005). Lastly, performance on reading tasks in the early grades was still lower than expected (Chibamba et al., 2018; Kaani & Joshi, 2013; Matafwali & Bus, 2013; Sampa et al., 2018; Tambulukani & Bus, 2012).

Following these concerns, the Ministry of Education implemented a similar language and literacy intervention which was now more extensive in terms of using the local language not only in Grade One but from preschool to Grade Four, this was contained in the 2013 National Literacy Framework. This programme called the Primary Literacy Programme (PLP) consisted of two parallel English Language courses, one in which oral literacy was emphasised and the other in which literacy skills were emphasised equally. As a result, instructors in these two English courses were advised to stick to more straightforward methods of communication. The other two components of PLP were policy guideline statements, with the first four grades using local familiar languages as the medium of instruction and from Grade 5 onwards, using English as the primary medium of teaching (Chishiba & Manchishi, 2016).

In an attempt to examine the linguistic policy in Zambia, it is worth noting that the language and literacy policy was simple and straightforward during the pre-colonial times, with a focus on seven local Zambian languages but it over looked the multilingual affordances of the Zambian education system. Following independence, there was a strategic shift where English was the language of instruction and local languages were now taught as subjects. The trend has since been reversed whereby Zambia's language and literacy policy has reverted to local languages being legally employed as a medium of instruction from preschool to Grade Four in all the public schools throughout Zambia's ten provinces. Although Zambia has implemented the mother tongue-based education policy in primary education, culturally appropriate instructional materials, sufficiently trained teachers and desired literacy competencies in preschool remain low (Matafwali & Bus, 2013; Mwaba et al., 2016; Tambulukani & Bus, 2012; Thomas & Thomas, 2009; Zimba, 2012).

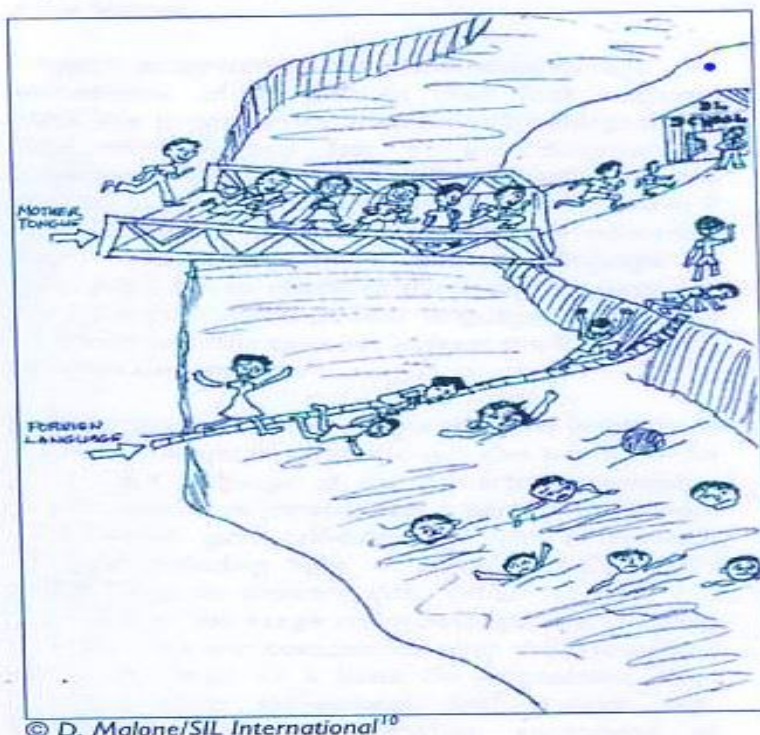
As a result, it is critical to remember that as children progress from preschool to primary school, providing engaging and motivating phonological awareness support for later reading competence is cardinal, and that these interventions should be delivered in the child's home language, which provides a strong foundation for literacy acquisition. Looking for technology-enhanced learning environments that are not only learner-centred, engaging, and intriguing but also delivered in the familiar language for children is one way to addressing the low literacy levels among early grade learners in Zambia. Like it has already been observed, the low reading levels in public early grade learners are due to the wrong language of instruction (Chibamba et al., 2018; Mwanza-Kabaghe, 2015; Tambulukani & Bus, 2012). The need to teach oral language through technology-enhanced play tools is gaining popularity in preschool education in Zambia (Kaumba, 2014). The extent to which language contributes to literacy in Zambian children is the focus of the next section.

### **1.1.2 Role of Familiar Language in Facilitating Literacy Development**

Having explained the language and literacy developments that have occurred in Zambia in the earlier paragraphs, there is need to examine how language, specifically the familiar language contributes to literacy in preschool children. One of the building blocks for learning is the familiar language. By familiar language, we mean the language that the pre-schooler used to learn new concepts and information when in school and at home. Helping children to understand new concepts based on what they are already familiar with is important both for teachers and caregivers (Mwansa, 2017). For children to easily acquire literacy skills that are fundamental for learning different things, it is necessary to use the familiar language (Kaani, 2014; Matafwali & Bus, 2013; Scheepers et al., 2021). When children are subjected to an unfamiliar language

during the reading acquisition process, they have to learn the foreign language first before they can use that language to master the reading process. This could be longer and difficult route to attaining literacy skills. Simply put, as illustrated in figure 1 below, the process of reading acquisition in the foreign language is more difficult compared to the familiar language. Figure 1 shows that compared to the children taught with the familiar language, those taught to read in the foreign language experience difficulties in acquiring literacy skills. The process of literacy acquisition in this illustration is compared to crossing the river. While children familiar with the language of instruction would easily cross the river (acquire literacy skills), the children who are unfamiliar to the language would fail to cross the river and end up drowning.

**Figure 1: Comparison of Students Learning Through Their Familiar Versus Unfamiliar Languages**



**Source:** Malone, D. L. (2003). Developing curriculum materials for endangered language education: Lessons from the field. *International Journal of Bilingual Education and Bilingualism*, 6(5), 332-348.

To help children master early skills that help to maximise their learning opportunities in terms of language and linguistic skills, it may be helpful to focus on expanding their vocabulary in a familiar language. This would improve their ability to understand the subjects being taught. Children acquire their first language in a gradual, unique, and rapidly developing way between the ages of one year, six months and three years; all they need is a supportive and nurturing home and school environment to do so. Acquisition of the first language proficiency is accomplished by prolonged immersion in the target familiar language (Kaani, 2014). Language proficiency in the spoken language is a prerequisite for both emerging and later literacy. In light of this, it stands to reason that learning to read and write is facilitated by one's familiar language.

The following account for the existing local evidence on the importance of the familiar language to reading development. Recent evidence emerging from the Zambian *Bemba* and *Namwanga* language contexts suggests that using a student's familiar language in the classroom promotes their ability to become proficient readers in that language (Kula & Mwansa, 2022). Similarly, in a study conducted by Mkandawire (2017), where one primary school used *Chinyanja* as the language of instruction, while the other used English, it was found that although both the *Chinyanja* and English played important roles in literacy acquisition, students were more engaged in a *Chinyanja* lesson than the English one. In addition, students would be more likely to participate in class discussions and answer questions posed by teachers if they were able to do so in the *Chinyanja* spoken in urban settings. In support, Tambulukani and Bus (2011) found that when students practice reading in their familiar Zambian language, they make greater gains in word reading fluency in both that language and English. They suggest that to improve the many potential ways to improve reading instruction, more should be done to examine the many facets of familiar languages.

Contrary to the view that familiar languages promote literacy acquisition, some researchers in Zambia (Sampa et al., 2018) compared two literacy programmes, one based on the language experience approach and the other on phonics, to see which one was more effective in helping young children learn to read. An explicit and systematic phonics-based literacy programme appeared to have benefited students in all four languages by increasing their familiarity with letter sounds. The group exposed to the phonics-based literacy condition outperformed those who participated in the language experience group in all measures of reading proficiency (word recognition, fluency in reading aloud, and comprehension). Sampa et al (2018) argued that the high floor effect in reading-related measures that was observed suggests that most children do not learn to read the transparently written language they are already fluent in when taught using either the phonics-based literacy or language experience programme.

Initially, the author provided a historical background of the language in education policy and then discussed the contribution of the familiar language to literacy development in the Zambian context. This was done to advance the idea that for young children to benefit fully from formal educational opportunities, there is need for them to be grounded in the familiar language of instruction that will enable them to actively participate and succeed in that language. This is consistent with the widely accepted view that a familiar language promotes emergent literacy to a large extent especially when children are fluent and socially functional in the target language.

Literacy digital interventions (like GraphoGame) may be helpful for both teachers and children when teaching the sounds of letters (Jere-Folotiya et al., 2014; Nshimbi et al., 2020; Ojanen, Jere-Folotiya, et al., 2015; Ojanen, Ronimus, et al., 2015; Walubita et al., 2015). The need to use digital tools to promote emergent literacy is further discussed in the next section. There is need to provide a transition

into the next section. From Digital training tools to This argument, there is no smooth transition to digital technology, language and literacy development.

### **1.1.3 Digital Technology, Language and Literacy Development**

The terms digital rhymes and stories in the local language development are used here to refer to the presentation of stories in *Chinyanja* using various multimedia techniques such as tablets and smart phones. Advancements in technological innovations over the years have not spared early childhood education and learning. Technology enhanced learning tools have now become part of the learning environment and experience of children (Borleffs et al., 2018; Ojanen, Jere-Folotiya, et al., 2015). It is less expensive to provide learning materials on digital mobile devices especially for poor and marginalised learners (Ogegbo & Aina, 2020; Wollscheid et al., 2016).

Over the past three decades, there has been discussions about how digital devices can be used to help pre-schoolers learn to read. The widespread adoption of new forms of digital learning may contribute to this trend. Teachers and researchers now have access to a plethora of tools that allow them to make well-informed decisions about the use of technology in the classroom. Understanding students' motivation, interest, and engagement for completing classroom assignments is made easier through the use of digital technology. In developed settings, interactive digital tools, such as digital stories, support literacy development and allow students to understand challenging words and phrases, master vocabulary, visualise objects, and engage with touch screen devices for easy navigation, are now available in classrooms (Hofslundsengen et al., 2020; Wong, 2015). Digital technology provides students with new opportunities for learning in a fun and engaging way. Students can view and discuss digital stories from multiple viewpoints as they explore the practical

applications of skills, strategies, and rules in interactive digital environments (Taylor et al., 2020).

Automation, robotics, and other forms of artificial intelligence (AI) are increasingly dominating the workplace and other formerly human tasks in the modern world (Taylor et al., 2020). To achieve this goal, the next generation of Zambian students will need to be fluent in the use of educational technologies. To help mould and construct a more ideal digital society, this calls for complete adoption of technology in educational settings. This is in line with the recent UNESCO (2021) agenda of making sure that schools can help students get ready for the digital future by teaching them how to adapt to new technologies, make sense of massive amounts of data, and work together effectively (Taylor et al., 2020). The current research was driven by a desire to better prepare the next generation of students, and particularly, Zambian preschoolers, for a classroom environment heavily reliant on digital technologies. Many studies (Fokides & Kefallinou, 2020; Heindl & Nader, 2018; Kotsari & Smyrniou, 2017; Moyer et al., 2018) included here, support the use of digital technologies for improved student learning outcomes, engagement, and motivation. However, most of these studies report findings based on teachers' perceptions, knowledge, and attitudes while working with digital technologies. The purpose of the research was to examine how local digital stories and rhymes can aid in the development of early reading skills. Presented below are studies that focus on the literature surrounding language acquisition through exposure to digital stories and nursery rhymes.

The purpose of the study by Eubanks et al (2018) to investigate the effect of digital story telling (DST) on the narrative-writing skills and confidence of Chinese elementary schoolchildren. The use of DST was found to increase motivation, writing ability, engagement, listening, speaking, and reading. The second study was conducted

by Oakley et al (2018) who investigated the impact of digitally shared personal, cultural, and traditional narratives on students' academic performance. Based on the results of the research, it is clear that DST paves the way for more opportunities to hone linguistic and cultural competence, digital literacy, and 21st-century skill sets.

When it comes to learning language, digital technology has also been helpful because linguistic progress depends on technologically enhanced environments (Vungthong et al., 2017). The study by Vungthong and others (2017) found that songs were enjoyable language opportunities that promoted student engagement and vocabulary, but could not exclusively enable vocabulary uptake and understanding without teacher guidance. The videos were mounted on touch screen devices and were aimed at first and second graders learning English. These results lend credence to the argument that teachers play a pivotal role in shaping and fortifying their students' vocabulary knowledge (Vungthong et al., 2017). Eutsler et al., (2020) conducted a systematic literature review to bolster these findings by analysing the impact of ESL learners' progress through fifth grade. Using the touch screen interventions provided, the study found that students' phonics, vocabulary, and comprehension all increased. This provided evidence for the claim that specialised touch-screen apps for teaching literacy can improve students' grasp of the language.

The importance of teachers in scaffolding digital technology to support language-related learning outcomes related to reading outcomes in the early years is also highlighted by Wilkes and his peers (2020). Most of the research presented in the preceding paragraphs emphasize the value of language-enriched materials made available through digital technologies. However, this supplementary material should not stand in the way for the instruction of a trained professional (Wilkes et al., 2020).

#### **1.1.4 The Role of Executive Functions in Child Development**

Executive functions, especially in children, set the child for success in all domains of human development such as physical, cognitive, social and emotional domain (Ahmed et al., 2021; Alduncin et al., 2014; Loe et al., 2015; Morgan et al., 2019). Empirical evidence abound on the associations between executive and literacy and mathematics (Cortés Pascual et al., 2019). However, lack of executive function development does not only have short-term but also long-term consequences to the child, family, community and nation. For instance, when the child is frustrated for not being able to acquire basic academic skills such as reading and arithmetic, the child may fall far below the peers. This is likely to result in dropping out of school. When this happens, the child might be set to engage in criminal behaviour in the community. This would be costly for both the family and the community who have to come to the aid of this individual when he or she is imprisoned. The nation loses out in terms of judicial and criminal costs involved when the individual is tried by the courts of law (Fitzpatrick, 2014). As opposed to an individual who succeeds in school and pays taxes when employed or engaged in income generating activities, the individual who drops out is a financial, social and moral burden to the family and society which stands to incur heavy expenses when the individual does not succeed academically and professionally. Hackman predicts the huge cost of not educating early grade learners to be covered by national treasuries (Hackman et al., 2015).

#### **1.1.5 Impact of Executive Deficits on Emergent Language and Literacy Development**

Pre-schoolers afforded the opportunity to overcome their maladaptive patterns of behaviour and acquire healthy skills that enable them to wait for their turn for things, follow the teacher's instructions and complete their work are more likely to learn in the

classroom than children who behave in the opposite direction. Such children will easily focus on the task at hand and pay attention to instructions. Executive function skills are crucial for keeping and guiding the pre-schoolers' behaviour and task performance, so they play a huge role in filtering out irrelevant information and overcoming distractions so that learning can occur. Pre-schoolers who are lacking in executive functions are more likely to experience emotional and behavioural difficulties, to have trouble forming healthy relationships with peers and teachers, and to have more difficulty learning new skills in school (Savina, 2021).

Specifically, limitations in executive functions result in language and literacy impairments as revealed by Im-Bolter et al (2006) who studied 45 children with specific language impairment (SLI) and 45 typically developing language children (ages 7-12). They examined executive functions (shifting and updating) and found that there were significant differences in executive functions across groups, noting that the typically developing language children outperformed their peers on updating as a subcomponent of executive function. These results backed up the hypothesis that linguistic proficiency, which facilitates emergent literacy could be predicted by executive functions such as updating (Im-Bolter et al., 2006).

Similarly, Marton (2008) whose goal was to compare children with SLI to typically developing children in terms of executive function, visuospatial processing, and working memory found that when compared to typically developing children, children with SLI had significantly worse performance on all tests of visual working memory (Marton, 2008). These findings were confirmed by a meta-analysis of about 46 studies that specifically tested inhibitory control and cognitive-flexibility. It was found that both components of EF tasks yielded poorer results for children with SLI compared to their typically developing peers.

More recently, regarding the influence of executive functions' limitations on literacy development, Chinese children with word reading deficits (WRD) or a specific reading comprehension deficit (S-RCD) were studied. The study found that children with WRD had deficits in both working memory and inhibitory control compared to the typically developing group, while children with S-RCD also experienced working memory deficits (Zou et al., 2022). In support of these results, Fong and others (2022) also examined executive functions (EF) to see if they play any role in the early reading difficulties that some Chinese children experienced. The results of this longitudinal study revealed that after controlling for age and nonverbal IQ, poor readers had much lower EF scores than average readers did in every single EF domain that was tested. Poor readers were found to experience inhibition control deficits.

It is clear from the studies cited that executive functions support language and literacy development. One limitation emerging from the reviewed studies border on the narrow context from where prior studies were conducted. The above stated studies involved mostly English and Chinese languages. Differences exist between English and Chinese compared to other languages such as *Chinyanja*. Because of these differences, the results could not be generalised to other settings. This suggests that the current study which investigates *Chinyanja* in addition to English, Italian, Greek and Chinese warrants attention because it is a transparent language (Kaani, 2014, 2021; Kaani & Joshi, 2013). Although the influence of executive function deficits on emergent literacy falls below the scope of the current study, it is important to highlight the role of executive functions in supporting language and literacy development especially in pre-schoolers.

Furthermore, the current study of a transparent language is motivated by prior studies of the positive effects of executive function interventions to improve language

deficits in Italian, which has transparent spelling system like *Chinyanja*. Research on transparent spelling in languages like Italian has shown that specially designed EF interventions can be helpful for children at home with specific language disorders (Maggio et al., 2021; Pecini et al., 2015; Tressoldi et al., 2012; Tucci et al., 2015). Reading proficiency, among other academic abilities, can be improved through computerised training of executive functions (Holmes & Gathercole, 2014; Johann & Karbach, 2020). Similar general executive function interventions have been investigated. The next section provides a review of executive function interventions among preschool children.

### **1.1.6 Executive Function Interventions**

Due to the pressing need to learn more about how young children become active participants in the learning process, executive functions have attracted attention in the literature. Specifically, preschoolers who are able to self-regulate may be better able to take advantage of the educational opportunities presented to them. The following are some of the interventions targeting executive function skills in young children.

A recent systematic literature review by Cardoso, Dias, Senger, Colling, Seabra, and Fonseca (2018) analysed nineteen (19) empirical studies that used computerised cognitive training among young children aged below 6 years. The review found that executive functioning interventions in typical children were effective in improving selected executive functioning skills such as working memory. For instance, Huber, Yeates, Meyer, Fleckhammer and Kaufman (2018) examined how exposure to various media platforms (watching an educational television show, playing an educational app, or watching a cartoon) affected executive functioning. In that study, 96 Australian children aged between 2 and 3, children who played an educational application

improved their working memory and did well on the gift delay task while those who viewed a cartoon did not do as well. To confirm these results, Rode, Robson, Purviance, Geary and Mayr (2014) assessed the effectiveness of a 17-session, computerised working-memory training intervention among 282 third-grade American children and found strong improvements in the training task (working memory). Further, pre-test and post-test data showed that working memory training was extended to school achievement tasks. In addition to the studies by Huber and others (2018) and Rode, Robson, Purviance, Geary and Mayr (2014), the study by Blakey and Carroll (2015) further provided support for the long-term effects of working memory training. Blakey and Carroll (2015) studied the effects of a short 4 session executive function training program among 54 lower and middle class 4-year-old children in the United Kingdom and found that after the working memory training, improved working memory effects persisted and were extended to mathematical reasoning 3 months later. Blakey and Carroll, later, concluded that executive function training effects during the preschool years were not only transferable to academic abilities but were also long-term.

Executive functioning training has been effective in not only working memory but also other executive functioning components such as inhibitory control. In view of this, Liu, Zhu, Ziegler and Shi (2015) found that response inhibition training, an aspect of inhibitory control central for early cognitive development could possibly improve reasoning ability (Raven's Progressive Matrices tasks) among pre-schoolers. Using 3 pre-test–post-test experiments, Li, Subrahmanyam, Bai, Xie and Liu (2018) compared the effects of viewing versus interacting with either fantastical or real events among 4- and 6-year-old children's inhibitory control. In the first and second experiments, they found that viewing fantastical events resulted in reduced inhibitory control while the third experiment showed that after viewing and interacting with real events, children's

inhibitory control increased. These findings suggest that merely viewing videos is not enough, children need to interact with the material they are watching and the content needs to be close to reality as much as possible to stimulate response inhibition and interference control.

### **1.1.7 Zambian Public Preschool Education Context**

Public preschool school pupils have experienced a variety of challenges, including poorly paid and demotivated teachers, an uncoordinated curricula, scanty teaching and learning resources, understaffed and overcrowded classrooms (Beyani, 2013; Kaunda & Ailwood, 2021; Mwaba et al., 2016). It is for this reason that this study focused on the Zambian public preschool system. In view of this, the following discussion is based on the Zambian public preschool system.

More Zambian children are now being enrolled in public preschools than in the past. The increased preschool enrollments could be attributed to the recent Ministry of Education's policy to free education to all children. Statistics from the Ministry of Education indicate that before 2011, only 47,317 children were enrolled in preschool. Since then, the figure drastically increased to 184,398 in 2017 (Munsaka & Kalinde, 2017; Ministry of Education, 2017). Currently, an increase from 17.1 per cent in 2007 to 35 per cent of children have access to early childhood education, especially in rural and remote areas (UNICEF, 2021; *Latest ECE Statistics in Zambia 2023*).

In terms of local research, Mwanza-Kabaghe (2015) found, among first-grade learners (preschool background versus non-preschool background) in public schools in Zambia that children who attended preschool did not perform better on literacy and numeracy tasks than those without preschool experience when later tested in first grade.

Regarding executive functions, the study by Mwanza-Kabaghe (2015) reported that preschool experience did not improve executive functions. Consequently, she recommended that preschools in Zambia needed to have interventions that typically target executive functions. Munsaka and Kalinde (2017) provided the reasons for the limited executive function skills among preschool learners in Zambia. They reported that early childhood education centres (similar to preschools) in Zambia lacked effective teaching and learning methods that provide a safe, playful atmosphere (what others refer to as play-oriented learning) which stimulates optimal physical, psychosocial and intellectual development (Kaunda & Ailwood, 2021; Lungu & Matafwali, 2020; Thomas & Thomas, 2009; Zimba, 2012).

There is need to support children as they learn through cognitive stimulation, imaginative, child-friendly play. This support later results in optimal cognitive development (Munsaka & Kalinde, 2017). Research in Zambia (Fink et al., 2012; Matafwali & Chansa-Kabali, 2017; Zuilkowski et al., 2012) has confirmed that preschool education in Zambia is not responsive to the needs of pre-schoolers because of the lack of facilities and human resources that support cognitive, linguistic, motor and socioemotional development (Hasan et al., 2015a), limited qualified teachers, lack of coordination among key stakeholders implementing early childhood programmes, limited national curriculum and policy framework and low exposure to early childhood care and education experience are some of the pressing challenges faced (Thomas & Thomas, 2009; Zuilkowski et al., 2012). This discouraging situation is likely to continue if no interventions are put in place to alleviate these challenges.

Among children entering first grade, only 43 per cent are aged 7 years. This disadvantages them in terms of learning outcomes, because it is not easy to switch

directly from the home to the primary school environment and sit to listen to the teacher for considerable hours each day (Kaunda & Ailwood, 2021).

There are a number of challenges that hinder the development of cognitive skills in Zambian children who are enrolled in public Early Childhood Education Centres (ECEC), also referred to as public preschools (PP). The following section discusses five challenges evident in the early childhood education in Zambia. First, Zambian parents and caregivers lack knowledge about the effect of cognitive stimulation and playful parenting on child development. This ignorance results in focusing more on physical care of young children, rather than cognitive and socioemotional care which has a greater influence development (Tucker-Drob & Harden, 2012). The limited capacity on cognitive stimulation among Zambian parents could attributed to the lack information among caregivers in rural areas (Brudevold-Newman et al., 2018). In addition, most caregivers and parents have not been sensitised on the recent availability of early childhood education in existing public primary schools (Kaunda & Ailwood, 2021; Thomas & Thomas, 2009).

Second, the number of qualified public preschool teachers who are trained in appropriate early learning pedagogies is still far below the number of learners enrolled in the preschools in Zambia (Hasan et al., 2015b; Kaunda & Ailwood, 2021). Third, lack of teaching and learning resources have been a major problem in the provision of quality preschool education in Zambian preschools (Matafwali & Chansa-Kabali, 2017). Teaching and learning materials in the language of instruction are not only inadequate but are also non-child friendly (Tambulukani & Bus, 2012). Fourth, the language of instruction used in the classroom by the teacher is not consistent with the language that children regularly use at home. For instance, while Chichewa is the language that is used by the teacher in class, the learners use town Chinyanja either

during play with peers or when at home. This inconsistency in the language of instruction which is common in Lusaka province schools sampled in the study could disadvantage children during the learning process (Mwanza-Kabaghe, 2015b). Finally, the preschool buildings in terms of suitability of classroom space, toilets and play facilities are not up to the required standard and are non-child-friendly. This may be because they were not built for preschool learners (Simui, 2017).

It is clear from the local research cited above that the Zambian preschool school education needs sufficient attention if children are to be well-prepared to learn by the time they enter Grade One. Research has shown that school problems seen in later higher grades originate from the early years (McDonald & Thorne-Lyman, 2017; Simui, 2017). Therefore, more needs to be done in preschool for overall optimal learning development to be achieved. Cognizant of the numerous challenges faced in early childhood education sector, the Ministry of Education, which is the custodian of the education in Zambia has made some efforts in the provision of quality early childhood education.

The next section discusses government's efforts in ECE provision. Zambian scholars have commended the Ministry of General Education for the introduction of the long-awaited mother-tongue medium of instruction that has achieved improved literacy outcomes (Nshimbi et al., 2020; Sampa et al., 2018). Second, the development of the early childhood education directorate, a department within the Ministry of General Education appropriately tasked with overseeing early childhood education programmes in Zambia that has never been seen before since Zambia's independence in 1964. This department has the potential to attract funding from different cooperating international partners who could contribute to the development of the early childhood education programmes, which are non-existent (Simui, 2017).

Third, the successful registration and certification of Zambian teachers through the Teaching Council of Zambia (TCZ), established in 2014 is yet another development that has occurred in the education sector. This development has resulted in the implementation of the code of ethics for teachers and registration of over 100, 086 teachers countrywide, a step towards standardisation of the teaching profession in Zambia (Kaunda & Ailwood, 2021; Nawa, 2018). These developments have a huge positive influence in the current provision of quality preschool education in Zambia. Fourth, introduction of teacher education programmes in early childhood education in public colleges of education is yet another positive development that is earmarked to increase the number of preschool teachers in the country (Munsaka & Kalinde, 2017). For instance, some colleges of education in Zambia such as Kasama and Kitwe Colleges of Education among others, successfully implemented these ECE programmes. Finally, ECE teacher recruitment into public ECE centres is another positive development. For instance, there has never been any preschool teacher recruitment since 2012, when the first ever recruitment was conducted where 1,000 teachers countrywide were employed to teach in the early childhood education sector (Kaunda & Ailwood, 2021; Munsaka & Kalinde, 2017).

Having discussed the challenges and achievements in the early childhood education sector, there is room to argue that among all the efforts towards quality provision of early childhood education in Zambia, there are no interventions have been implemented that target the role of executive functions in emergent literacy development in Zambian public pre-schoolers. The section that follows will provide reasons for the development and implementation of well-designed, culturally relevant early reading and language instruction in the Zambian preschool classroom.

### **1.1.8. Assessment of Executive Functions in Children**

Having provided the Zambian preschool context in the preceding sections, there is need to discuss executive function (EF) assessment in children because it is after EF assessment that interventions are designed. For instance, the design of appropriate classroom interventions for academic skills followed effective assessment strategies of working memory (Bergman-Nutley & Klingberg, 2014). First, a description of the two assessment approaches of executive functions will be provided, then the advantages of direct assessment over adult reports will be examined and recommendations will be provided to include both types of assessment approaches in the effective measurement of executive functions in children.

Children's abilities to follow the teachers instructions, create and meet learning objectives, persevere in the face of difficulties, understand what they are learning, control their emotions and interact with others in a constructive way, make informed decisions are together referred to as executive functions (Weissberg et al., 2015). These cognitive functions are categorised in three groups namely, working memory, inhibitory control and cognitive flexibility. Since these skills are complex because they require interaction of various social, emotional, and cognitive skills which are influenced by contextual circumstances, it is challenging to obtain a "real" measurement of children's executive functions (Obradović & Steyer, 2022). This is the reason for the multimethod approach to executive function assessment. This is simply the use of two types of assessments in an attempt to capture all aspects of executive functions. The two assessment approaches are the adult reported (observer-reports) and performance-based (direct tests) assessments of executive functions. The practice of combining these two assessment approaches helps to comprehensively assess executive functions in children. While direct assessments employing performance-based activities contribute

to an objective understanding of the children's executive function skills as they are acquired and implemented across diverse environments, adult reports, on the other hand, provide a subjective assessment of children's executive function-related actions in a given context (Obradović & Steyer, 2022).

Some of the advantages of using direct assessments including performance-based tests have been emphasized in the literature (McCoy, 2019). Compared to adult reported measures of working memory, direct assessments unbiasedly involve asking a child to repeat numbers or visual sequences of increasing length, which is not attainable with measures that depend on adults' impressions of how well a child can recall and carry out series of complex tasks. This implies that direct measures are able to provide information that is not possible to get when using adult reports when assessing executive functions (Blair et al., 2016; Zelazo et al., 2016). The benefits accrued from direct assessments do not suggest that adult reports are irrelevant. Obradovic and Steyer (2022) argue that the two assessment approaches should co-exist because direct measures fail to capture EF skills applied in real-life contexts. They argue that instead of replacing observer reports with direct tests, the two types of assessments should both be administered.

Consistent with this notion, Fuhs and others (2015) have argued that performance-based tests show the EF skills that an individual child possess, while observer ratings show how those skills may or may not be used. The children's EF abilities in a natural setting, such as a classroom is captured by the observer ratings while their performance in the laboratory setting could be estimated by the performance test. Fuh and colleagues note that rather than performance-based tests, observer ratings can be especially helpful for understanding children's EF skills in real-world classroom settings. The current study assessed executive functions and phonological awareness

because of the established consensus that the two are related (Chung & McBride-Chang, 2011; Czapka et al., 2019; Kwakkel et al., 2021). The next section unpacks the development of phonological awareness specifically rhyme awareness, which is the focus of the present study. The development of rhyme awareness is the focus of this study because deficits in rhyme awareness have been reported to cause learning difficulties in young children (Lima & Basto, 2014; Rosal et al., 2016).

### **1.1.9 Development of Phonological Awareness**

Many definitions of phonological awareness have been provided in the literature, with each offering a relatively acceptable amount of theoretical and empirical support. Phonological awareness (PA) is described as the ability to identify, consciously think about and manipulate language speech sounds (Bus & Van IJzendoorn, 1999). Phonological awareness is how well a child understands that words are made up of sounds. Simply put, the child's ability to both divide the spoken word into its component sound units phonemes and then combine these units into a single word demonstrates phonological awareness (Nesdale et al., 1984). Anthony (2005) further offers a detail description of PA by suggesting that phonological awareness skills are based on two considerations. First, the type of PA task being performed and second, the size of the sound unit of focus. For instance, does the task require any of the four aspects of phonemic awareness: blending sounds, separating words into their individual sounds, recombining the sounds of words, and/or judging whether two words sound the same? The other aspect to consider is the size of the sound unit of interest in this task, is it the syllables or the smaller intra-syllabic units (onsets, rimes, or phoneme).

As argued by Mwansa (2017) these subcomponents of phonological awareness have to a large extent influenced literacy instruction in most early grade learning

contexts in Zambia (Chilufya, 2008; Mwansa, 2017; Ojanen, 2007; Sampa et al., 2018). While some literacy teaching methods have focused on examining the letter-sound correspondences (the relationship between the letters of the alphabet and the sounds they make), others have focused on the onset-rime awareness (reading each part of the word separately; mostly the initial sound [onset] and end sound [rime], and then combining the parts to say the entire word). The question whether one approach is better than the other has been the subject of empirical inquiry. Most of the literature seems support the letter-sound reading approach than the onset-rime approach (Bowey, 2002).

In the context of this study and consistent with the psycholinguistic grain-size theory (Kaani, 2014), the onset-rime approach is preferred due to two reasons. First, rhyme awareness requires minimal cognitive load because it is the lowest level of phonemic awareness (Cunningham & Cunningham, 2002; Santos et al., 2020). Second, the emphasis on rhyme awareness in this study arises from the scarcity of research that focusses on rhyme awareness and bantu languages. It is clear from the literature that rather focussing how rhyme awareness affects bantu languages, most of the studies have studied English and rhyme awareness (Diemer et al., 2015). This is partially what makes the present study unique because rhyme awareness in a Bantu language has been investigated.

As depicted by Figure 2, the commonly accepted theory of phonological awareness development, starts with the ability to recognise rhymes through syllable awareness and into the ability to delete and manipulate phonemes as the final stage (Adams, Foorman, Lundberg, & Beeler, 1998; Anthony et al., 2002; Lewkowicz, 1980). This theory assumes that phonological awareness develops from the large (sentences, words and syllables) to the smallest sound units (phonemes). The size of the phonological unit and the degree of manipulation required determines whether or not

the child will complete the phonological task (Carroll et al., 2011). Carroll and others argue that tasks that involve hearing and manipulating small units (phonemes) are much more difficult to complete than those that require larger units (syllables or rime units). Rhyme awareness, in the context of this study is easier to achieve because it involves accurate judgement of the similarity between sounds in ending words compared to most difficult phonological tasks such as phonemic awareness, which demand more complex cognitive skills (Ziegler & Goswami, 2005).

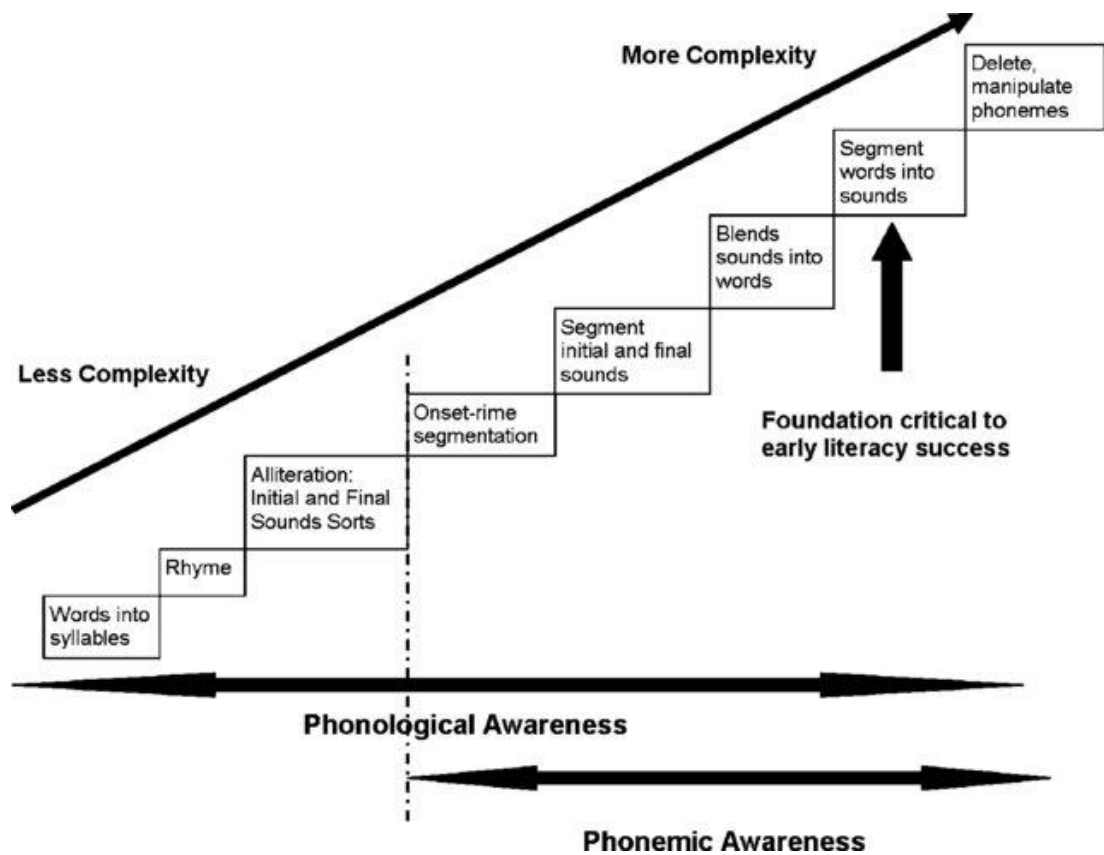
This above stated psycho-linguistic grain size theory which is a word recognition model fits in the current study through its mention of large linguistic units (rhyme awareness). There is strong evidence that transparent orthographies, like *Chinyanja*, allow readers to rely on phoneme-to-grapheme correspondences, while readers of opaque orthographies must develop orthographic units of large sizes. But research among bantu languages shows that this is not necessarily true for speakers of transparent orthographies (Probert, 2016; Ziegler & Goswami, 2006). Larger grain sizes such as rhymes can also be relied on for literacy development in transparent languages (Arduino & Burani, 2004; Cunningham & Cunningham, 2002). *Chinyanja*, the focus of this study is also a transparent language (Kaani, 2014). The nature of *Chinyanja* as a transparent language makes it possible and interesting to examine how rhyming in this language can be facilitated by executive functions.

One of the limitations of this theory regarding the development of phonological awareness skills is that it does not explain whether or not teaching rhyming promotes advanced phonological awareness (Hindson et al., 2005; Macmillan, 2002; Stuart, 2005). Although lower-level skills such as rhyming provide the foundation for emergent literacy instruction or intervention, phonemic awareness more than rhyme

awareness is widely known to be the most important predictor for reading according to a meta-analysis by Melby-Lervåg (2012) .

Rather than looking at the developmental stages of phonological awareness as sequential, it is necessary to perceive these stages as overlapping than standing alone. This is consistent with the view that phonological awareness is a partial-parallel progression (Anthony et al., 2003). Put simply, if a child has already mastered one skill, then it is easier for them to move on to the next. Having a firm grasp on earlier skills should be optional. For this reason, as a child progresses through the curriculum, they learn and perfect a number of phonological awareness skills concurrently (Anthony et al., 2003).

**Figure 2: The Development of Phonological Awareness in Children**



Source: Scheele, C. M., & Boudreau, D. (2008). Phonological awareness intervention: Beyond the basics.

Rhyme awareness described as the ability to recognise rhymes, is the earliest and easiest emerging phonological skill in childhood which develops spontaneously owing to the minimal cognitive processing required to recognise rhymes (Santos et al., 2020). Regarding age progression in the development of phonological awareness, Bradley and Bryant (2013) found that onset-rime awareness develops first, around the age of four. For children aged 4 and 5, the oddity task, which measures knowledge of rhyme was successfully done (Bradley & Bryant, 2013; Kirtley et al., 1989). In another task where children were had pick out rhyming pairs, this task was also well done (Carroll et al., 2003).

A child's ability to segment words into syllables and not into phonemes also developed at around 4 years old, while phoneme awareness emerged later, in part as a result of reading and writing instruction (Goswami, 2002a; Scarborough, 1998). In order to test the phonological development theory by examining children's ability to distinguish between syllables and phonemes, Bradley and Bryant (2013) found that more 4-year-olds could complete syllables than phoneme tasks. Among 6-year-olds, most of them could segment syllables, compared with segmenting phonemes. This wealth of evidence supports the theory that phonological awareness develops along a large-to-small scale.

Rhyme awareness is a foundational phonological awareness skill that paves the way for later development of a more nuanced awareness of individual syllables and phonemes within words. Longitudinal studies provide evidence linking phonological awareness to children's reading success. In addition, it was discovered that the ability to recognise rhymes has a direct bearing on the reading (Goswami, 2002b; Jing et al., 2019). Listening to rhyming words makes it easier for a child to identify similar words. Thus, opportunities that allow for children to listen to rhyming words such as those in

provided in the local digital rhymes and stories in the current study emphasize recognising rhyming words which build on to more advanced phonological awareness skills for later reading (Goswami, 2002b).

#### **1.1.10 Phonological Awareness and Reading**

Recent longitudinal and neuroimaging studies suggest that phonological awareness support emergent literacy (Gandolfi et al., 2021) and reading acquisition (Wang et al., 2021), consistent with prior research (Bus & Van IJzendoorn, 1999). Specifically, phonological awareness is moderately correlated with reading as shown by meta-analytic investigations (Bus & Van IJzendoorn, 1999; Swanson et al., 2003).

Phonological awareness is one aspect of children's metalinguistic awareness that emerges during the preschool years, prior to the development of reading, and continues to develop into the elementary school years (Blachman, 2000; Farrar & Ashwell, 2008; McBride-Chang, 1995). Both correlational and experimental studies have shown that phonological awareness is foundational to later reading success from the first and second grade into the later elementary grades (Anthony & Lonigan, 2004; Brady, Fowler, Stone, & Winbury, 1994; Bryant et al., 1990; McBride-Chang, Wagner, & Chang, 1997; Wagner & Torgesen, 1987; Whitehurst & Lonigan, 1998).

#### **1.1.11 Role of Rhymes and Stories in Literacy Development**

Traditional approaches to early literacy instruction, such as questioning, explanation and repetition, can be dull and uninteresting for young learners. As a result, this would have a negative effect on their motivation to learn. In order for children to be able to use and master the language, language and literacy teaching methods should more accurately mimic how language is actually used in the real world (Conesa & Rubio,

2015). Using songs and rhymes like it was done in this study, is one of the effective ways of teaching language in an exciting, engaging and child-friendly manner. There is no doubt that young children enjoy the use of rhymes and songs during learning. Studies have shown that letter knowledge of the alphabet is better mastered by young learners when children learn the letters through a song than through the traditional teaching method (Nadera, 2015; Throne, 2020; Yeni & Amelia, 2020). Songs and rhymes are a universal medium of communication because they use tones and rhythm to convey meaning. Similarities in the ways that language and music convey meaning are well-documented (Aldridge, n.d.; Bolduc, 2008; Runfola et al., 2012; Wiggins, 2007).

Children's ability to recognise, match, and produce rhymes is one of the earliest phonological skills which involves the ability to decode phonetic patterns (Scheepers et al., 2021). Essential skills developed at the pre-primary and primary levels of children's education which include rhyme awareness may be a significant aid in the development of phonological awareness in the case of preschool learners (Grofčíková & Máčajová, 2020). This is because learning to recognise rhyme requires the child to listen for individual sounds within words, which, in turn, gives the child a foundational understanding of how words are broken down into their constituent sounds (Grofčíková & Máčajová, 2020). Rhymes offer children numerous opportunities to hear sounds because of their highly repetitive nature. Because of this, young children are able to expand their vocabulary and acquire a deeper understanding of a specific language in use. This is one of the reasons for the current study's focus on rhyme awareness.

Reading readiness is a prerequisite for learning to read, and literacy experts are beginning to recognise the contribution of musical and verbal experiences to emergent literacy development (Adu & Frimpong, 2018; Allen, 1996; Goswami, 2002a; Harper, 2011; Pourkalhor & Tavakoli, 2017). When used with deliberate intent, rhymes and

stories can be a valuable learning tool to help children learn to read and write. Emergent literacy is not only about reading but also about writing. Other factors that contribute to reading and writing include speaking and listening, which help to enhance skills in written and read languages. Previous findings have found that rhymes play a crucial role in the emergence and growth of early literacy skills (Adu & Frimpong, 2018; Andrews & Baker, 2019; Goswami, 2002a; Harper, 2011; Pourkalhor & Tavakoli, 2017). One of the possible explanations for this is that in the early stages of literacy development, listening and speaking provide the foundation for later literacy outcomes. If practiced regularly, literacy-oriented listening and speaking from a young age, tends to lead to a higher level of reading proficiency. For one to succeed as a fluent reader, they need adequate listening and speaking opportunities which are encouraged when a child is exposed to rhymes and stories. Learning phonics and sight words require one to manipulate sounds to recognise rhymes.

Rhymes and stories are especially helpful in building children's literacy skills because they enhance phonemic awareness. "Playing with rhymes is an important part of tuning a child's ear to the rhythms and sound patterns of language," (Allen, 1996). The foundation for building phonological awareness is the ability to isolate and identify individual sounds in a word (phonemes). Decoding and analysing unknown words requires the ability to segment words into phonemes, which is developed through phonemic awareness in young children (Konza, 2011). Learning to hear and differentiate between beginning and ending sounds is an important precursor to reading and writing (Goswami, 2002a).

Songs, rhymes, and stories especially when embedded in technology enhanced devices are fun and exciting recreational activities that are enjoyed by children. Children tend to profit from early exposure to rhymes and songs that introduce them to

the concepts of music, which is part of play for children. When children are in preschool, rhymes and stories are exciting and easy teaching tools that help to engage the learners (Zhong & Guo, 2022). The actions of clapping hands, dancing, singing on the part of children helps to make children be attentive and is one way of incorporating play into literacy instruction for better cognitive outcomes (Kalinde, 2016; Vermeulen & Kalinde, 2016).

Exposure to local rhymes and stories is one of the ways children can learn the different components of a specific language. Listening to rhymes and stories helps children develop the skills necessary to connect letters to their specific sounds (Goswami, 2002a; Harper, 2011). Learning to identify and create rhymes is a crucial step in expanding one's phonological repertoire. Phonological awareness has been shown to correlate with reading ability (Chiappe & Siegel, 1999; Hogan et al., 2005; Verucci et al., 2006). Early exposure to rhyme and stories improves literacy skills even though phonemic segmentation is a stronger predictor of later reading than rhyming or vocabulary (Yeh & Connell, 2008).

In Zambia, especially in the urban areas where the majority of Zambia's modern popular music is generated, rhymes have been mainly used in these songs for entertainment rather than educational purposes. For instance, most of the local Zambian songs played on radio and television contain rhymes. These songs are mostly sung primarily in the two languages that are most frequently utilised in modern Zambian popular music: Nyanja and Bemba (Chilala, 2019). The song sung by Petersen, a popular Zambian Musician uses the following words "kandolo/mumufolo", "mabili-bili/kambwili-mbwili" which are clearly intended to rhyme (Chilala, 2019, p.93). This is just one of the many Zambian popular songs that use rhymes to tell different types of stories that preschool children in Zambia dance to. The use of rhymes in Zambian

popular music could be a justification for the use of rhymes in the current study and by extension, recommend their use in teaching and learning contexts to promote language and emergent literacy development. Another reason for the current study's interest in rhymes emerges from disturbing observations made by Zambian music expert that English rhymes/folk songs and Sunday school songs are currently the most often used songs in preschools in Zambia (Kalinde, 2016).

Our enhanced understanding of the role of rhymes in emergent literacy development as stated in this section helps to explain the current main study's focus on the impact of executive functions in moderating the effect of rhymes and stories on phonological awareness. The role of executive functions in phonological awareness is the subject of the next section so that phonological awareness are a set of skills that are regulated by executive functions (Kwakkel et al., 2021; Segers et al., 2016; van de Sande et al., 2013).

#### **1.1.12 The Role of Executive Functions in Phonological Awareness**

Throughout their cognitive, behavioural, and social-emotional development, children's executive functions play a crucial role in the child's overall neuropsychological functioning. Executive functions, specifically working memory and inhibitory control have been found to support emergent literacy and vocabulary (Becker et al., 2014). More recently, the ability to recognise and manipulate onsets and rimes in a spoken language, a precursor to phonological awareness is related executive functioning (Yang, 2021; Blair and Razza, 2007; Medina, 2021; Cardoso, 2013; Moura, 2015). Rhyme awareness, a process that depends on the coordination of executive functions depends on working memory and inhibitory control.

Among the cognitive skills that facilitate rhyme awareness is executive function, which is defined as a family of advanced cognitive skills that are used for planning, problem-solving, and updating and/or maintaining information to achieve goal-directed behaviour (Diamond, 2013; Miyake et al., 2000). To manipulate linguistic units such as phonemes during the early reading stages, a child needs executive functions (Medina, et al., 2021). For instance, in order to successfully complete the task of rhyming "mat" with "rat.", one needs to remember the sounds of each word and recognise the familiarity between them, both of which are necessary to apply the linguistic rules of rhyming. The ability to remember similar sounding words and how they are related facilitates processing mechanisms such as inhibiting distracting information, holding information in mind to achieve a task, decoding and manipulating the phonological structure of a language for rhyme awareness to be attained (Mulder et al., 2017).

Executive functions may help develop phonemic awareness in preschool learners from public school backgrounds. Well-designed emergent literacy interventions such as *Tools of the Mind* paying attention to executive functions demonstrate great success in improving academic outcomes such as reading (Barnett et al., 2008).

## **1.2 Justification for the Present Study**

The following sections account for the reasons why the author focused on preschool years, executive functioning and phonological awareness in the present study. First, focusing on preschool years is critical because that is the time when key developments take place in all domains including cognitive, socio-emotional and sensorimotor (Council, 2000). In terms of brain development, neurogenesis, axonal and dendritic growth, synaptogenesis, cell death, synaptic pruning, myelination, and gliogenesis are

all processes that are at their peak during preschool years (Bettcher et al., 2016; Panikratova et al., 2020; Takeuchi et al., 2013).

The other reason for drawing attention to the preschool years is because the brain at this stage is vulnerable to risk factors such as stress, under-nutrition and poor cognitive stimulation so, the earlier the intervention, the greater the possibility of recovery (Rutter & O'Connor, 2004). We believe that focusing on the preschool years is one of the early intervention strategies for a vulnerable brain. Related to this, our focus on executive functions is motivated by the established positive association between executive functions and academic success that have been observed in a number of preschool studies (Blair & Razza, 2007; Bull et al., 2008; Fuhs et al., 2014; McClelland et al., 2007).

The third reason for investigating executive functions is that it is linked to the socio-economic situation of the Zambian children (McCoy et al., 2015). Studies have shown that economically disadvantaged children tend to enter school with lower executive function skills because of the toxic stress and anxiety experienced as a result of poverty and poor parenting (Blair et al., 2011; Noble et al., 2007). The limited executive functions manifest in struggles with maintaining focus in class, finishing work, and controlling impulses (Blair & Diamond, 2008). This calls for more research in Zambia on the link between executive functions and learning outcomes because most of the children enrolled in public preschools come from low-income backgrounds. Such an undertaking is of particular importance as executive function skills mediate the relationship between socio-economic status and academic success in reading and mathematics (Nesbitt et al., 2013).

Given that children in urban areas of Zambia have been exposed to mobile devices and spent large amounts of screen time without help, there is need to

incorporate instructional resources in these mobile devices (Jere-Folotiya et al., 2014). For children in low-resource contexts, the development and implementation of high-quality, culturally relevant early reading and language instruction in the preschool classroom is critical (Moody, 2010; Moody et al., 2010). There is now a greater focus on instructional techniques that produce better learning outcomes. Researchers have long been interested in electronic narrative books as an effective method of literacy and language instruction in preschool learners (Salmon, 2014; Smeets & Bus, 2012; Smeets, 2012; Takacs et al., 2015).

Some of the reasons for the use of a locally developed and culturally appropriate digital literacy intervention programme targeting preschool learners in Zambia are presented as follows. First, lack of sufficient practice of the language of instruction among preschool learners in public schools in Lusaka Province has exacerbated the lack of teaching and learning materials in the local language (Matafwali, 2010; Tambulukani & Bus, 2012). The problem of mastery of the medium of instruction has been made worse by the interference of English on *Chinyanja*.

Second, poor literacy and language teaching methods have contributed to the low reading levels among early grade learners (Ojanen, Ronimus, et al., 2015). This situation prompted the introduction, although quite late, of the National Literacy Framework, a literacy and language policy that was aimed at addressing the low literacy levels and poor literacy teaching methods (Sampa et al., 2018). In response to the poor literacy situation in Zambia, non-governmental organisations partnered with the Finish government to introduce a computer-assisted intervention called Graphogame, a video game designed to enhance letter-sound correspondence for early grade learners (Jere-Folotiya et al., 2014; Nshimbi et al., 2020; Ojanen, Jere-Folotiya, et al., 2015). Although, recent evidence suggests that Graphogame holds promise for improving

literacy in African developing countries (Dean et al., 2021), computer-based emergent literacy interventions that ignore the basic pattern of literacy skill development may be deemed ineffective.

Duncan (2018) suggests that development of syllable and rhyme awareness takes place earlier than letter-sound sensitivity, this means that initial literacy interventions targeting phonological awareness skills need to focus more on the earlier-developed literacy skills such as syllable and rhyme awareness that develop earlier before focus on letter-sound correspondence is emphasized. The current intervention focused mainly on rhyme awareness, a skill classified under the basic phonological skills in the hierarchy of phonological awareness (Anthony et al., 2003).

The fourth reason for the rhymes and stories intervention in this study stems from the non-school-related factors such as lack of literacy-related home interactions whereby parents do not read to their children and there are few literacy-related resources accessible to non-readers in the home. What is even more unsettling is that many Zambian parents themselves are unable to read (Brudevold-Newman et al., 2018) and that could be the reason for not reading to children or to other people (Chansa-Kabali, 2017). The absence of a reading culture is mostly attributed to functionality rather than pleasure. Reading in Zambia is mostly of survival purposes such as for employment search in newspapers and school-related purposes (Sampa et al., 2018).

Fifth, the absence of locally developed cognitive assessment tools in public preschools and assessment centres (Chitiyo & Dzenga, 2021; Ojala, 2004) motivated the current study, which would produce ecologically validated cognitive tests that will be used as screening tools for early grade learners in public schools. These problems that have been highlighted in the literacy and language context in Zambia in the preceding paragraphs surely require a high-quality locally developed and culturally

appropriate digital literacy intervention programme. This that will stimulate practice in the local language of instruction in preschool aged children in public schools in Lusaka Province.

Finally, concern on the four research questions relates to the cross-cultural question of executive function studies conducted in individualistic cultures assuming results were generalisability to collectivistic societies such as Zambia, where children have been found to suffer from diseases likely to disrupt their optimal cognitive functioning (Adams et al., 2019).

### **1.3 Problem Statement**

Although, recent research indicates that generally executive functions (EF) play a role in phonological awareness (Kwakkel, Droop, Verhoeven & Segers, 2021; Yang, Yang, & Kang, 2021; De Witt & Lessing, 2017), the specific role of inhibitory control as a component of executive function in moderating the relationship between an emergent literacy intervention and rhyme awareness is unknown among public preschool learners in Zambia (Nshimbi, 2021; Jere-Folotiya et al., 2014; Ojanen, Jere-Folotiya, et al., 2015; Ojanen, Ronimus, et al., 2015). This gap in knowledge could result in limited understanding on the role of attention in emergent literacy tasks among preschool children who learn in deprived conditions. Consequently, well intended emergent literacy interventions among public preschool children may not be effective because the skills that moderate their optimal performance could have been ignored.

Another problem is that other levels of phonological awareness have been examined at the exclusion of low levels of phonological awareness such as rhyme awareness (Schuele & Boudreau, 2008). Furthermore, the relationship between EF and mathematics skills appears to be stronger and more consistent than the relationship

between EF and literacy skills (Blair & Razza, 2007; Fuhs et al., 2014; Sasser et al., 2015; Verdine et al., 2014). In addition, most of the literature is based on older rather than young children (pre-schoolers) who have not yet started reading (Beisly et al., 2020, 2022). These gaps warrant further investigations on the moderation of executive functions in the link among stories, rhymes and rhyme awareness in public preschool settings.

Despite a wealth of studies on executive functions and phonological awareness (Fong & Ho, 2022; Santos et al., 2020; Scheepers et al., 2021; van de Sande et al., 2013), the local understanding of the role of specific executive functions in specific basic phonological awareness skills such as rhyme awareness is limited. To begin, there is substantial scarcity of local studies on rhyme awareness and inhibitory control. The majority of local research has mainly focused on the role of home literacy and socio-economic status in predicting executive functions (Mutambo, 2021), the influence of executive functions on reading comprehension (Namakando, 2021), early numeracy attainment (Chalwe, 2017), and literacy and numeracy (Mwanza-Kabaghe, 2015a). Second, the development of executive functions in preschool has not yet been addressed in local research, despite the fact that these studies have concentrated on older children like those in grades one, two, four and seven (Chalwe, 2017; Mutambo, 2021; Mwanza-Kabaghe, 2015a; Namakando, 2021). Third, it is unclear whether direct compared to reported executive function tests predict rhyme awareness. Lastly, prior studies on the performance of executive functions were limited to only one assessment approach that utilised the direct test (Mulenga et al., 2001). Thus, a recent and thorough study such as this one is required to inform literacy instruction practice and identify gaps in the local research on the interconnection among the three disciplines namely executive functions, emergent literacy and rhyme awareness in public preschool learners. In order

to better understand the role of executive functions in determining the effect of emergent literacy intervention on rhyme awareness, the current study was conducted.

More children are now being enrolled in public preschools than ever before as a response to the recent Ministry of Education's policy to introduce public free early childhood education in primary schools in Zambia. Statistics from the Ministry of Education indicate that before 2011, only 47,317 children were enrolled in preschool. Since then, the figure has drastically increased to 184,398 (Ministry of Education, 2017). The majority of the children that enter public preschools in Zambia find it challenging to complete executive function tasks. Although research has been conducted in Zambia on executive function, in terms of investigating the executive functions of older children from the home literacy, socio-economic, numeracy, comprehension and literacy perspectives, few studies have examined the role of executive functions among preschool learners from low-income family backgrounds enrolled in public schools in Lusaka Province.

#### **1.4 Purpose of The Study**

The purpose of this study was to examine whether executive functions moderate the relationship between Chinyanja digital rhymes and stories and rhyme awareness among Zambian preschool learners enrolled in public schools, using an experimental between-subjects research design.

#### **1.5 Research Hypotheses**

The following are the specific hypotheses that this study tested:

1. Hypothesis 1: Learners perform better on executive function (EF) tasks from preschool to Grade One.

2. Hypothesis 2: Executive functions predict phonological awareness (rhyme awareness) skills.
3. Hypothesis 3: Performance-based executive functions tests will better predict phonological awareness (rhyme awareness) skills compared to observer reports of executive functions.
4. Hypothesis 4: Executive functions will moderate the relationship between rhymes, stories intervention and phonological awareness skills (rhyme awareness).

In this study, executive functions were treated as a moderator variable, whereas the intervention (*Chinyanja* digital rhymes and stories) was the independent variable and the dependent variable was phonological awareness (rhyme awareness). Hypotheses and not research questions were used because the author was interested in building up previous knowledge about the role of executive functions in emergent literacy interventions. Previous studies provide information on general aspects of executive functions and not specifically addressing inhibitory control and sustained attention (Beisly et al., 2020; Chalwe, 2017; Namakando, 2021; Sasser et al., 2015).

### **1.6 Significance of the Study**

The present study is relevant and justified for the following reasons. First, the current study is one of the few first initiatives in Zambia to document *Chinyanja* digital rhymes and stories that only existed in past oral traditions. This study is in line with what Banda and Morgan (2013) advocated, which is to incorporate folklore and indigenous knowledge as practiced by the local community into the formal curriculum in order to improve the quality of education delivered to all native people and preserve their cultural identity.

Second, different from other studies in terms of its approach to the problems faced by Zambian children today among them the low reading levels, the approach used in the present study is solution-oriented as it seeks to identify ways of addressing these problems. By problem-oriented, the present study refers to previous child development studies conducted in Zambia have described factors that contribute to the current reading problems among early grade learners in Zambia (Jere-Folotiya, 2014; Jere-Folotiya et al., 2014; Matafwali, 2010; Mubanga, 2015; Mwanza-Kabaghe, 2015a). The current study makes a unique contribution to addressing the reading problem by searching for an intervention that will help to address the gap that exists between the descriptive studies and intervention studies in the field of early grade literacy in Zambia. There is need for research in Zambia to go beyond merely describing the problem. The current study aims at addressing such a gap.

Third, the Ministry of Education is implementing the use of local and familiar languages medium of instruction in the preschool and lower grades. This policy which was introduced in 2012 is supported by a great deal of empirical evidence globally (Chibamba et al., 2018; Kula & Mwansa, 2022; Matafwali & Bus, 2013). The current study is focused not only on supporting the Ministry's language policy by using the language of instruction, but also encouraging other preschool service providers to help the Ministry achieve the desired national literacy targets of ensuring all young children attain appropriate basic reading and writing skills (Banda & Mwanza, 2017a). The current study builds on existing evidence that oral language predicts reading among Zambian primary school learners (Matafwali & Bus, 2013; Tambulukani, 2015).

Fourth, the present study utilised *Chinyanja* digital rhymes and stories which were intergrated in an interactive tablet, This interactive approach to learning has been recommended by experts in the field of early childhood education (Kalinde, 2016;

Munsaka & Kalinde, 2017). This approach has been shown to improve learning outcomes among preschool children (Lungu & Matafwali, 2020; Nakawa, 2020).

Fifth, the present research design used in the present study is ranked among the most reliable and valid research methods in the scientific community (Hampton, 2018; Keren, 2014). The research design used in the present study aids in understanding the cause and effect of targeted learning outcomes. It is proposed that future child development research in Zambia should focus on robust and rigorous methods similar to those used in the present study.

Sixth, less research attention has been paid to preschool children in Zambian public schools. In order to support this argument, when we review the six (6) studies conducted during the time of the present study that targeted early grade learners in urban Zambian schools (Chansa-Kabali, 2015; Jere-Folotiya et al., 2014; Matafwali, 2010; Mubanga, 2015; Mwanza-Kabaghe, 2015a), none of these studies recruited preschool learners as their participants. The current study has addressed the knowledge gap by examining the Zambian low-income urban preschool sample. Some Zambian scholars have argued that the neglect of preschool learners in research can partially be attributed to the delayed decision by the Zambian Government to officially recognise early childhood education as a formal mainstream education sector (Munsaka & Kalinde, 2017). This situation contributed to not having public preschool education in the current Zambian education system for a long time.

Seventh, most executive functioning studies among preschool children have been conducted in high-income countries such as Australia, USA, Canada or China. Studies based on western populations have limited space in the Zambian context because of the wide socio-cultural contextual differences that exist. Based on this clear

scarcity of research in this field especially in developing countries like Zambia, the present study is timely and relevant.

Eighth, executive function (EF) performance, particularly, in preschool learners has received attention in the literature. It has even been listed as the most studied topic in child developmental neuropsychological research. Several empirical studies have examined age-related differences in preschool. However, most of these studies have examined older children rather than preschool-aged children. Past research mainly investigated the dynamics of executive function using cross-sectional research rather than longitudinal studies to comprehensively examine the developmental nature of executive function in preschool children.

Ninth, the current study focuses on the role of executive functions in moderating the relationship between *Chinyanja* rhymes and stories have been used in promoting rhyme awareness in Zambian preschool children. This is important for the following reasons. First, there is general consensus in literature that whereas preschool children have been exposed to digital media technology either through their peers or care givers, there are few studies devoted to investigating the role of executive functions in mediating the association between a local digital intervention of rhymes, stories and rhyme awareness (Anderson & Subrahmanyam, 2017; Blumberg et al., 2019). Second, the current study is relevant because recent evidence in Zambia has demonstrated that participation in early childhood learning programmes predict better preschool cognitive outcomes including executive functions (Chivweta, 2014; Ndhlovu et al., 2016; Simasiku, n.d.; Thomas & Thomas, 2009). In addition to the lack of digital rhymes and stories in the appropriate language of instruction (Fink et al., 2012; Matafwali & Bus, 2013; Tambulukani & Bus, 2012) currently experienced in the Zambian ECE sector, there are very few preschool teachers trained in ECE teaching methods across the

country (Munsaka & Kalinde, 2017). Third, this study is important on account of evidence that stress is related to child poverty in Zambia (McCoy et al., 2015). Poverty-induced stress predicts poor executive function outcomes in children (Allee-Herndon & Roberts, 2019). Lastly, the lack of focus on executive function in the current preschool curriculum underscores the need for this study especially that executive functions have been demonstrated to improve learning outcomes including reading and mathematics in preschool learners.

Finally, the present study brings a unique approach to understanding child development and learning among Zambian preschool children as it builds on what Graphogame has mainly focussed on. Graphogame is an intervention tool for enhancing emergent reading skills among early grade learners found to be effective in the Zambian urban and rural setting (Jere-Folotiya, 2014; Lyytinen et al., 2019; Nshimbi et al., 2020; Walubita et al., 2015). While Graphogame falls short of providing literacy that can enhance reading fluency and comprehension, skills that are only acquired when the child is intrinsically motivated to read sufficiently beyond letter sound level, the tablet enhanced stories and rhymes being offered by this intervention programme come in to bridge this gap.

The significance of the current study is classified into three levels. National, institutional and individual. At the national level, the study may inform stakeholders of the need to include executive function in the current early childhood curriculum so that teachers can prioritise the development of this set of skills that enable preschool learners to easily learn and adapt to the classroom setting, an environment that the youngest learners find to be intimidating and stressful. With regard to the institutional significance of the present study, information generated from the study could enlighten the current teacher education programmes in universities and colleges of education to

place emphasis on the need to prepare preschool teachers on how to improve executive function skills of young learners in preschool. At the individual level, the findings of the study might also help to uncover literacy-related learning opportunities of technology enhanced tools for young learners in Zambia.

This study is relevant for the Zambian context on account of the following four reasons as presented in the order of importance. Firstly, the study was undertaken in order to identify interventions that would mitigate executive function deficits reported in Zambian children (Mulenga et al., 2001; Mwanza-Kabaghe, 2015a). Secondly, increased exposure to technology among children (Kabali et al., 2015; Wood et al., 2016), accompanied by both positive and negative experiences of technology in the Zambian modern society among children, warranted this longitudinal research. Thirdly, the absence of executive function content in the current preschool policy, curriculum and teacher education protocols motivated the current study. Consistent with Mwanza-Kabaghe (2015), executive function training needs to be included in the Zambia preschool syllabus. Last of all, the present study was conducted to address theoretical and methodological challenges experienced in the study of the influence of technology on executive functions in preschool aged children (Koutromanos & Kazakou, 2020).

### **1.7 Theoretical Perspectives**

This study was influenced by the executive functions-academic achievement theory developed by Nesbitt, Farran and Fuhs (2015). A detailed description of this theory is presented in chapter three of this report.

The theory that informs the present study is located within the preschool development field and that is the reason why it informs this study. For the past three

decades, executive functions and academic achievement (EFAA) theory developed by Nesbitt et al., (2015) has been widely used to understand the relationship between executive functions and academic learning outcomes in preschool aged children (Sasser et al., 2015). The current study applied this theory to explore the moderation role of executive functions in the relationship between an emergent literacy intervention and rhyme awareness. Research has found that, in line with this EF-AA theory, executive functions have been found to positively influence varied learning outcomes such as the development of maths ability (Blair et al., 2016), reading comprehension (Meixner et al., 2019), emergent literacy skills (Blair & Razza, 2007; Farrar & Ashwell, 2012), letter and decoding (Fuhs et al., 2014), and word reading (Chung & McBride-Chang, 2011).

Although the theory which frames the present study helps to understand the associations that exist among the three variables of interest in this study, the theory was developed in a context that is different from Zambia. This limitation prevents the generalisation the prior findings on this theory to the Zambian population. Thus, there is need to collect as much information as possible about the theory and how it can be applied to the Zambian public preschool context.

### **1.8 Operational Definitions**

The following terms are defined within the scope of the present study in order to facilitate a deeper understanding of the study's central concepts:

**Executive functions.** Cognitive skills that were assessed using the pencil tap test, Stroop-like test and the digit span test.

**Emergent literacy.** Skills, knowledge, and attitudes that develop before the conventional forms of reading and writing.

**Performance-based tests.** Use of a specific executive function tests in collecting data that required the participant to demonstrate knowledge, skill, or a particular behaviour.

**Observer rating scale.** Use of an observer report reflecting on participant 's learning, skills, or behaviours, rather than a demonstration of these abilities and behaviours.

**Digital local language rhymes and stories.** 12 minutes long videos that contained rhymes and stories installed on a portable 7 inches Samsung tablet computer.

**Pre-schooler.** Child aged 5 or 6 who attended a formal early childhood programme annexed to the sampled 14 public schools.

**Phonological awareness.** Sensitivity to the spoken parts of words and sentences of which rhyme awareness was the main phonological skills examined in this study.

**Rhyme awareness.** The lowest level of phonological awareness assessed using the three researcher-made tests, *Chinyanja* rhyme production test, *Chinyanja* rhyming picture test and the picture rhyming test. This involved the participants' focused attention on the sound similarities between words.

**Preschool teacher.** A person employed by the Ministry of Education to teach in public preschools.

**Public preschool.** A school registered and funded by the Ministry of Education. The public preschool in this context were initially referred to as early childhood education centres annexed to the primary public schools.

**Inhibitory control.** A cognitive ability assessed by the pencil tap and Stroop tests in the present study.

**Moderation.** When executive functions change the influence of the digital rhymes and stories intervention on rhyme awareness.

**Working Memory.** Storing a small amount of information in mind and used in the execution of cognitive tasks that was measured by digit span and Stroop test.

### **1.10 Summary**

This chapter presents the context of study including the factors that influence emergent literacy development namely, phonological awareness, familiar language, rhymes, stories, executive functions, digital technology and the nature of the public preschool context. The statement problem, purpose of the study, the research hypothesis, significance of the study and a brief explanation of the theoretical framework that informed this study were provided. In addition, operational definitions of key terms and the unique contributions to the knowledge of this study were explained. In the next chapter, key existing studies on executive function development, the relationship between executive functions and phonological awareness and executive function assessment approaches will be reviewed to identify issues arising from the literature based on the stated hypotheses within the context of low-income public preschools in Kafue, Chilanga and Lusaka districts of Lusaka Province.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Overview

This chapter attempts to situate the current study within the general field of language, emergent literacy and executive functions in preschool-aged children. First, an explanation of how executive functions develop over time will be discussed, then, the extent to which executive functions are related to phonological awareness will be examined. An explanation of how executive functions mediate phonological awareness interventions will be offered and this will be followed by a discussion on the two executive function (EF) assessment approaches: EF performance-based and observer reported measures. In all the identified themes, an attempt is made to highlight the existing gaps and how the present study could address them.

#### 2.1 Introduction

Experience with oral language and rhyming can provide rare opportunities for children to be aware of the sounds in spoken words. This phonological awareness process is an important preparatory step towards emergent literacy. However, it is expected that not all children are exposed to rich and stimulating local stories and rhymes due to a number of factors related to the school, home and socio-economic factors such as adverse environmental conditions including poor emergent literacy pedagogies, lack of qualified teachers and learning resources, poor literacy parental practices and poor nutrition, housing and disease (Chung et al., 2017).

Creating a conducive emergent literacy environment needs to go hand in hand with the promotion of relevant cognitive skills that support emergent literacy development. Children with poor executive functions (especially those from poor

backgrounds) may fail to benefit from emergent literacy interventions due to stress induced by poverty. The current study explored the role of executive functions in moderating the association between an emergent literacy intervention and rhyme awareness. In light of this, the development of executive functions, the relationship between executive functions and rhyme awareness is explained in form of empirical evidence and the assessment approaches employed in the field of executive functions are explained in the later part of this chapter.

Phonological awareness, a complex metalinguistic skill that involves a conscious awareness of the spoken parts of words and sentences has been found to support reading development (Anthony & Francis, 2005; Caravolas et al., 2012, 2013; Ehri et al., 2001; Goodrich & Lonigan, 2016; Holliman et al., 2016; Kirby et al., 2003; Meira et al., 2019; Rodríguez et al., 2015). PA has been the focus of research because it is not only facilitated by executive functions but it is also a precursor for literacy acquisition.

Executive functions are a family of supervisory cognitive skills that help one to manage goal-directed behaviour and facilitate emergent literacy development. Emergent literacy is a process that calls for the synchronisation of a wide range of cognitive abilities such as inhibitory control, working memory and shifting. Therefore, it is expected that reading proficiency correlates highly with executive functions (Adams & Snowling, 2001; Altemeier et al., 2006; Booth, 2011; Carroll, 2004; Conners, 2009; Hughes & Ensor, 2011; Sesma et al., 2009). The findings linking rhyming and other phonological awareness skills to executive functions suggest that this link is attributed to the ability to pay more attention to the forms (i.e., the sounds of words) while ignoring the meaning. The use of inhibitory control, a subcomponent of executive functions in this skill is emphasized (Farrar & Ashwell, 2012).

The focus of this review is based on four key themes. Firstly, the development of executive functions in children, secondly, the relationship between executive functions and phonological awareness in preschool years and thirdly, the moderation of executive functions in phonological awareness interventions. Finally, the discussion will be around the two types of executive function assessment in children: performance-based and behavioural rating measures.

There is need to focus on four gaps that have been identified in the literature reviewed in the sections that follow. First, whereas a number of studies have examined older children's executive functions development mostly, from the western context, little is known about young children in low-resource settings. Second, although there is consensus that childhood working memory (executive function component) predicts certain aspects of phonological awareness namely, syllable identification (Navarro, et al., 2011), syllable and onset deletion (Chung & McBride-Chang, 2011; Yang et al., 2019), phonemic awareness (Santos, et al., 2021; Yang et al., 2014) and sound categorisation (Oakhill & Kyle, 2000), the extent to which inhibitory control predicts rhyme awareness has not been investigated in preschool children in Zambia. This gap motivated the current study. Third, whereas executive functions have been found to moderate mathematics interventions (Ernst et al., 2022; Fuhs et al., 2014; Ribner et al., 2017), the role of executive functions in moderating the relationship between emergent literacy interventions and rhyme awareness outcomes remains unknown. Finally, while performance-based measures and behavioural rating scales have been shown to be correlated (Kim & others 2021), it is not clear which of the two assessment approaches (performance-based measures and observer reported scales) predict rhyme awareness.

## 2.2 Executive Functions Development

Age differences in executive functions in children has been studied. Gandotra and colleagues (2021) examined 136 Hungarian pre-schoolers aged between 3 and 6 years old. They found that the age of the children had an effect on all the executive function measures (working memory, response inhibition and cognitive flexibility), revealing better performance for older children than younger children. These results were similar to those reported by other studies. Guerra et al (2021) investigated the development of executive functions among 230 Brazilian children aged 7 to 12 years and found that EF performance for most measures was affected by age indicating a maturational progression of executive function. Röthlisberger and others (2010) also confirmed the developmental progression of executive functions in 410 children (5-7 years) whose executive functions were inter-correlated with language, intelligence, motor coordination skills, self-regulation, and parents' socioeconomic background.

Other researchers have concluded that executive functions experienced rapid growth during the early preschool years. In support, Bock and fellow researchers (2015) also studied 7 to 12-year-old children and found that as expected, spatial working memory and flexibility improved significantly with age, especially among the 7 year olds. Consistent with other previous studies, these findings support the view that executive functions improve with age (Hamamcı et al., 2021).

The development of executive functions (EF) has also been explored by examining the difficulties experienced during executive function tasks among young children. For example, the study by Baker and others (2010) showed that 3-year-olds demonstrated more executive function errors than their 5-year-old counterparts. Over time, extensive literature has emerged on perseveration (executive function errors)

of typically developing young children on cognitive flexibility tasks (Kloo et al., 2010; Mack, 2007; Perner & Lang, 2002; Rennie et al., 2004; Towse et al., 2000; Zelazo, 2006). Executive function deficits of young typical children have been investigated in recent prior research (Bardikoff & Sabbagh, 2021; Kapa, 2021). These results suggest that the development of executive functions in preschool children improves with age but executive functions may not have differentiated in young children compared to older children.

In young children, only two constructs of executive functions can be identified: inhibition and working memory (Best & Miller, 2010; Miller et al., 2012; Scionti & Marzocchi, 2021; Traverso et al., 2015; Wiebe et al., 2011). The two factor model of executive functions suggests that other components of executive functions namely cognitive flexibility tend to emerge in older childhood years (Joyce et al., 2016; Monette et al., 2015). Although there is a general agreement that executive functions develop with age (Ferguson et al., 2021; Gandotra et al., 2021; Guerra et al., 2020), most of this research is based on populations of preschool children drawn from Western settings (Fink et al., 2012). In an attempt to address this research limitation, the present study investigated executive function development among preschool learners enrolled in public schools from Zambia, a non-Western country.

### **2.3 Executive Functions and Phonological Awareness**

In order to respond to the second hypothesis of this study, there is need to find out if executive functions (EF) and rhyme awareness are related. The importance of emergent literacy scaffolding by caregivers to provide a nurturing environment for young children is emphasized when the relationship between developing literacy skills and EF are examined. EF skills help students build their developing phonological awareness

skills, which are a strong indicator of future reading achievement. The relevance of this question is based on the claim that the majority of studies have examined other components of phonological awareness namely, word awareness, phonemic awareness, sentence awareness and syllabication but not rhyme awareness (Blair & Razza, 2007; Cameron et al., 2012; Goodrich & Lonigan, 2016; Kegel & Bus, 2014; Nayfeld et al., 2013). In view of this research gap, specifically focusing on the role of executive functions in rhyme awareness is important, especially in the Zambian preschool context which has been adversely affected by the dearth of research (Munsaka & Kalinde, 2017).

In a study that involved how attentional control, phonological awareness, and working memory all interact to bring about reading among pre-schoolers, Rezaei & Jeddi (2020), found that EF components such as attention, reaction inhibition, vigilance, and processing speed all had a statistically significant effect on reading. This statistical significance in the direct effect of phonological awareness on reading acquisition with the aid of executive functions might be useful in determining the role of cognitive processes in emergent literacy development in preschool children. The findings by Rezaei & Jeddi (2020) were supported by another study where 119 Chinese and 139 American pre-schoolers were tested on a battery of EF tasks (i.e., inhibition, working memory, and attentional control) as well as reading and mathematics, and it was found that attentional control predicted reading (Lan et al., 2011).

These results have been replicated in other studies that will be revealed in the following paragraphs. Inhibitory control, working memory, vocabulary knowledge, and phonological awareness, among others, were assessed in 85 Chinese kindergarten children (ages 4-5 years). After accounting for age, vocabulary knowledge, and metalinguistic skills, the combination of working memory and inhibitory control

explained 16 per cent of the variance in word reading at both ages (ages 4-5 years). Additionally, even when word recognition at time one was statistically controlled, executive function skills yielded unique variance to word reading at time two (Chung & McBride-Chang, 2011). Although these findings highlight the unique role of executive functions for the development of emergent literacy, much of these research findings have limited applicability to non-Western preschool setting including the Zambian preschool context.

Yang and colleagues (2019) also investigated the contributions of executive functions (working memory, inhibition, and reasoning) to phonological awareness among Chinese children aged 5 - 6 years. The study found that children's ability to read Chinese characters was influenced by phonological awareness, working memory, inhibition, and reasoning. Executive functions not only contributed to word reading acquisition but also facilitated character reading in Chinese. Phonological awareness (PA) and executive functions have been shown to have bidirectional relations, with PA predicting executive functions and vice versa (Yang & Kang (2014). Among bilingual and monolingual children, English onset and Chinese rime awareness predicted the relationship between PA and executive functions. Despite suggesting that PA skills in Chinese contributed to the development of executive functions in the reviewed studies, only a handful of studies have been devoted to studying other languages extensively, especially in the Zambian local languages that have been targeted in this study. The majority of these studies that have examined the relationship between EF and PA have targeted syllable awareness mostly in English, Chinese and Spanish (Grofčíková & Máčajová, 2020; Míguez-Álvarez et al., 2022). Thus, the current study attempts to address this limitation by examining rhyme awareness in a Zambian language.

Examining the role of executive functions in rhyme awareness (RA) was investigated by Farrar and Ashwell (2012). In this study, children's ability to switch between different perspectives flexibly by blocking one and focusing on the other (inhibitory control), was significantly linked to rhyming ability in 4-year-olds. Blair and Razza (2007) also investigated children aged 3 - 5 years. This study examined how executive functions, specifically self-regulation affected phonemic awareness. The findings showed that self-regulation was a strong predictor of early mathematics and phoneme segmentation (Blair & Razza, 2007). The studies by Farrar and Ashwell (2012) and Blair and Razza (2007) suggests that executive functions have a role to play in the development of early reading skills in young children. In addition to the study of how executive functions relate to rhyme awareness, the predictive power of short-term memory tasks on two measures of phonological awareness: the sound categorisation task and a phoneme deletion test, was compared in 7 and 8-year-olds in a study conducted by Oakhill & Kyle (2000). Using a fixed-order multiple regression analysis, Oakhill and Kyle revealed that the sound categorisation task required more working memory capacity than the phoneme deletion task. Only on the sound categorisation task did working memory predict independent variance in performance. This suggests that for one to successfully complete a sound categorisation task, they need adequate working memory skills.

The majority of studies on the relationship between EF and RA have been restricted to only one sub-component of executive functions (working memory) neglecting the other types of executive functions such as cognitive flexibility and inhibitory control. These studies would have been more useful and holistic if they had focused on all the types of executive functions. To overcome this knowledge gap, the current study examined the link between inhibitory control and rhyme awareness.

Furthermore, the findings noted above have been supported by clinical research. Navarro et al., (2011) compared the results of 424 middle-class children, ranging in age from 4 to 7 years and revealed that children with poor phonological processing and inhibitory processes performed worse on early literacy outcomes, suggesting that poor executive function skills specifically inhibitory control, negatively affected emergent literacy outcomes. These findings were confirmed by another clinical study by Fox (2015) on children with speech sound impairments in which Fox discovered that these children scored much worse on executive function and phonological working memory tests than their counterparts who did not have any speech sound impairments. Fox (2015), and Navarro et al., (2011)'s findings are consistent with Peng and others (2013) who investigated executive function deficits among Chinese children with reading and mathematics difficulties compared to their typical peers. In this study, children with reading and mathematics deficits also exhibited difficulties in executive functions namely, verbal working memory, inhibition, and processing speed. Although, most of the studies that have been cited above suggest that executive functions are related to language and literacy development, these results were based upon data from clinical populations found to have either weakness in executive functions or phonological awareness, and it is unclear if the results of typically developing children would be different.

Although there is overwhelming evidence that preschool executive functions are associated with phonological awareness skills, the role of rhyming awareness, inhibitory control among typical preschool learners speaking a local Zambian language is not well understood because most of the studies have only focused on syllable identification, addition, omission (Navarro et al., 2011), syllable, onset deletion (Chung & McBride-Chang, 2011; Yang et al., 2019) and sound categorisation (Oakhill & Kyle,

2000) and other languages except Zambian languages (Bus & Van IJzendoorn, 1999; Chung et al., 2017; Grofčíková & Máčajová, 2020; Míguez-Álvarez et al., 2022; H. Yang et al., 2014a). The absence of studies that examine the link between rhyme awareness as a component of phonological awareness and executive functions, precisely inhibitory control partially motivated the current study, which sought to address these knowledge gaps by assessing phonological awareness using rhyme awareness and how this can be linked to executive functions in Zambian public preschool settings.

#### **2.4 Executive Functions as a Moderator in Phonological Awareness Interventions**

Having explained the role of executive functions in the development of phonological awareness in the preceding paragraphs, attention is now drawn to the role of executive functions as a moderator variable in early phonological awareness interventions.

Phonological awareness interventions conducted in different Western contexts suggest that well-developed programmes substantially improve emergent literacy skills in both primary and preschool learners. For instance, in a study conducted by Carvalhais and others (2020), GraphoGame was shown to have clear positive effects on spelling and phonological awareness among Portuguese struggling readers. Increased phonological awareness skills were observed in the intervention group compared to the control group. The ability to segment speech into sound units was tested in this study. Implicit awareness of rimes (identification of two rhyming words) and explicit awareness of syllables (identifying similar sounds in two words) improved for the experimental condition but not for the control group.

Improvements in rhyme awareness following emergent literacy interventions have been noted in both English and Chinese populations. For the 56 seven-year-old

children with low Pinyin skills who were randomly assigned to one of two groups: training or control, the three weeks' duration of playing the Pinyin GraphoGame, according to Li and colleagues (2020) revealed that children in the training group outperformed their counterparts in the control group on Pinyin reading accuracy, fluency, onset–rime, phonemic awareness, and character reading (Li et al., 2020). Pinyin GraphoGame, a digital based game that promotes emergent literacy has been shown to increase children's phonological awareness at the onset-rime, phonemic, and syllable levels (Li et al., 2020). The effectiveness of GraphoGame in promoting limited emergent literacy outcomes have also been demonstrated in Zambia (Jere-Folotiya, 2014; Kauppinen, 2014; Nshimbi et al., 2020; Ojanen, 2007; Walubita et al., 2015), but what has not been covered in the literature is the role of executive functions as a moderator variable in the relationship between emergent literacy interventions and rhyme awareness in preschool-aged children in Zambia. The current study is bringing this interesting aspect by interrogating the moderation role of executive functions in the relationship between emergent literacy interventions and rhyme awareness among typically developing Zambian preschool children enrolled in public schools.

Consistent with these findings, clinical studies have been conducted. One such study involved 40 children aged 5 to 7 years, diagnosed with hearing aid impairments. This study found that after a three-month computer-assisted (CA) phonological development intervention, phonemic awareness, mixing onset and rime, blending phonemes, medial phoneme identification, and final phoneme identification, improved (Sohail et al., 2018). Another intervention study examined the association between word recognition training and how this could improve rhyming skills (van Goch et al., 2014). In this study, four-year-old prereaders were randomly allocated to one of two groups: an experimental group that was taught pairs of new words or a control group

that received numeracy training. The experimental group performed better than the control group on a rhyming awareness test, implying that learning phonologically specialised new words promoted phonological awareness (van Goch et al., 2014). According to Ziolkowski and Goldstein (2008), low-income toddlers' ability to identify rhymes improved after exposure to a rhyme training. Preschool children aged 4 to 6 years who received a 9-week rhyme awareness intervention in the summer term of their final preschool year performed better on rhyme awareness and non-word spelling than those who were in the control group (Nancollis et al., 2005).

In an attempt to improve phonological awareness interventions so that they are more interactive and much more stimulating for young learners, Chera and Wood (2003) tested the effect of animated multimedia talking books in promoting phonological awareness in children with reading difficulties. These researchers discovered that giving young children 10-minute sessions of digital stories for four weeks improved their capacity to recognise pictures whose words sounded like the target words. In order to determine whether kindergarten Dutch children with specific language impairment (SLI) developed phonological awareness skills, Segers and Verhoeven (2004) administered a three- and half-hour computer-supported phonological awareness intervention and found positive effects of the intervention for the normal speech group. Eighteen weeks later, the effect size was still substantial. Prior research on experimental interventions that target components of PA such as phoneme awareness and phonics knowledge have demonstrated promising findings in these emergent literacy outcomes (Stuart, 1999).

Many similarities were found between the phonological intervention programmes that were analysed in this chapter. Phonological awareness, decoding, passage reading fluency, encoding (spelling), and even writing were all covered in

various degrees across all interventions (Toplak et al., 2009, 2013). Unfortunately, little attention was paid to rhyme awareness partially because it is the most basic phonological skill. Almost all of the interventions tried to improve students' ability to read, but few of them were particularly specific on preparing preschool children to read. Almost all of the interventions involved structured, direct teaching and not one of them examined the role of rhymes and stories which have been found to be less formal and structured emergent literacy teaching tools (Zhong & Guo, 2022).

Although the previous studies show that phonological awareness interventions are effective in promoting the development of PA during the pre-reading early years, a gap still remains in the literature regarding the role of executive functions as a moderator variable in the relationship between phonological awareness interventions and other emergent literacy outcomes such as rhyme awareness among low-income typically developing pre-schoolers in Zambia.

### **2.5 Executive Functions Assessment Approaches: Performance-based Measures and Observer Reported Measures**

In order to adequately study the role of executive functions in promoting early reading skills, it is important to critically examine how executive functions are assessed in preschool children in low-resource settings. In cognitive development, neuropsychology, and cross-cultural research, executive function is one of the most commonly studied discipline. An important question that affects the conclusions we can draw about executive functions is how to operationalise and measure them. In preschool settings, operationalisation of executive function is accomplished through the use of both performance-based or reported-based measures because executive functions are still developing in preschool children (Best & Miller, 2010; Blair et al., 2016; Moriguchi et al., 2016). Inhibitory control deficiencies, massive amounts of

distractibility, cognitive rigidity, a lack of coordinated or planned strategic behaviour and self-monitoring are often cited as reasons why pre-schoolers are unable to exert higher order control over relevant cognitive processes, emotional responses, and behavioural impulses (Isquith et al., 2005).

On one hand, performance-based assessments are standardised tests directly used to evaluate a child's executive functions. On the other hand, observer reported scales or called behavioural rating measures indirectly assess a child's level of executive function by having parents, caregivers or observers rate how difficult or easy it is to perform routine executive function tasks (Toplak et al., 2009, 2013). However, how performance-based and observer reported ratings of executive function contribute to rhyme awareness is still unclear. The present study aimed at targeting this knowledge gap. The following section will focus on the two types of executive function assessment approaches: performance-based (direct assessment tools) and observer reported rating scales (indirect measures).

Although research has established that performance-based and reported EF measures assess different EF constructs (Hamamcı et al., 2021; Toplak et al., 2013), what has not been sufficiently explored is how each of the two testing approaches predict rhyme awareness in preschool children (Toplak et al., 2013). The following studies draw attention on the association between performance-based and observer reported rating scales of executive functions. In this discussion, there is need to reflect on the contribution of each of the two assessment approaches to rhyme awareness.

Kim (2021) used the latent variable approach to investigate the longitudinal relationship between performance-based (PB) tests and corresponding observer reported rating scales in 101 normally developing pre-schoolers, and discovered that there was no direct relationship between these two EF measures. These findings were

replicated by Zonneveld and colleagues (2021) among minority children from low-income backgrounds. In support, the research conducted by Hamamcı et al., (2021) explored the similarities and differences between performance-based measures and parental and teacher ratings of executive functions in 200 Turkish preschool children. This study also found that there was little to no correlation between EF performance-based and parents and teacher ratings. These findings were confirmed by Schirmbeck and Maehler (2020). The argument that performance-based measures and behavioural ratings measure different abilities has also been supported by Toplak and colleagues (2013) who reviewed 20 studies and found that performance-based and rating measures of executive function reflect different underlying mental constructs. In addition, Eycke and Dewey (2016) found that different constructs of EF (animal sorting, inhibition, and response) as measured by parent-report scales were associated with different neurodevelopmental processes. Similar findings are reported by a study conducted by Anderson et al (2002).

One of the explanations for the point of departure between direct and indirect EF measures is that while performance-based tests provide a subjective evaluation of children's EF skills in a given context, observer reported measures provide an objective insight into children's cognition (Obradović & Steyer, 2022). This calls for the use of both assessment approaches to achieve a multimethod comprehensive assessment of EF skills. McCoy (2020) argues that performance-based tools are able to capture various components of EF skills that children need to succeed in the real world. Behavioural ratings, on the other hand, have ecological validity which makes them reliable tools of indexing the capacity to transfer skills from abstract situations directly into meaningful settings. McCoy recommends the use of both performance-based tests and behavioural

rating scales if we have to arrive at an accurate estimate of executive functioning in preschool settings.

Surprisingly, other studies have also argued that the two assessment approaches reveal similar outcomes and are correlated. Fay-Stammach and Hawes (2019) sampled 107 children aged 4–5 years and found that the BRIEF-P scales and performance-based measures reported small to moderate correlation. These findings were later confirmed by clinical samples examined by Krieger and Amador-Campos (2018) who found that children with Attention Deficit Hyperactive Disorder (ADHD) who recorded significantly low scores on performance-based tests, were also reported to have low EF rating scales, suggesting that scores on performance-based were related to performance on EF rating scales. The relationship between performance-based tests and behavioural rating scales was also observed in adolescents diagnosed of ADHD (Ledochowski et al., 2019; Toplak et al., 2009). Miranda et al (2015) used performance-based tests and EF rating scales to evaluate 209 children in their last year of preschool. The multiple EF measures (backward digit span, counting task, odd-one-out card task and the mazes memory tests) revealed moderate correlation values with behavioural rating scales such as BRIEF, although scores on the BRIEF had larger correlations with verbal working memory tasks. These findings suggest that using performance-based assessments and rating scales together, can give better reliable estimates of executive domains in ADHD. This view was supported by others (Hamamcı et al., 2021; Isquith et al., 2014). Most of the studies that claim that the two assessment approaches are related, however, suffer from the fact that they draw inference-based data collected via cross-sectional methods. Given that EF skills in children are still developing, there is need to monitor this development through longitudinal methods (Diamond & Ling, 2016). Despite contrary views on the relationship between the two assessment approaches, the present study

supports the view that the two types of executive function assessment approaches, reveal varied outcomes.

Furthermore, to strengthen the argument that performance-based measures bring out different executive function skills from those assessed by rating scales, McCoy (2020) reports of the findings of a meta-analytic study gathered from diverse EF assessment approaches and concluded that these two approaches (performance-based and behavioural rating scales) were fundamentally different and, as a result of this, they could not be comparable. According to McCoy's argument, performance-based EF assessments are reliable and bias-free, but they have limitations in terms of providing scores that can easily be interpreted. Bodnar et al., (2007) interrogated the relationship between parent ratings of inhibitory control and continuous performance tests (CPT) in two mixed clinical samples and concluded that the BRIEF (behavioural rating scale) appeared to measure different elements of inhibitory control compared to those assessed by computerised continuous performance tests (performance-based). In support of the argument that the two assessment tools (performance-based and behavioural rating scales) measure different constructs of executive functions, McAuley et al., (2010) also questioned the association between the behavioural rating scales and EF performance-based tests (Mahone et al., 2002; Vriezen & Pigott, 2002).

In order to resolve the discrepancy that exists between the results of performance-based tests and behavioural rating scales, Silver (2014) suggests that there is need to strengthen the psychometric properties of these two types of tests by using large diverse populations so that they can be comparable. Performance-based tests and EF rating scales can be used together in order to adequately capture executive functions. This is consistent with the recommendation offered by McCoy (2020).

In addition to using the two types of assessment side by side as recommended by others (Loe et al., 2015), there is need to search for EF rating scales that have strong psychometric properties and show consistency with performance-based tests such as the Childhood Executive Functioning Inventory (CHEXI) and Behavioural Assessment System for Children (BASC). The CHEXI has been shown to have test-retest dependability (Thorell & Nyberg, 2008). Another well-known behavioural rating scale commonly used in preschool is the Behavioural Assessment System for Children (Duggan, 2014) and the BRIEF (Gioia et al., 2000a, 2000b). The search for more EF behavioural rating scales used in varied language contexts needs to be examined (Fournet et al., 2015). The argument in the present study is provided by Isquith (2014) who claims that it is impossible to get a holistic impression of a child's executive functioning from just performance-based tests. In light of this, executive function assessment should combine the use of performance tasks that target specific aspects of executive function with parent/teacher ratings that target more global aspects of executive functions in the everyday context.

The studies cited earlier do not provide firm conclusions on executive function assessment in preschool years because in each of the studies cited, methodological complications characterise the manner in which executive functions have been measured in preschool aged children (Isquith et al., 2005). Finding appropriate performance-based measures and assessing real-world everyday activities is difficult. Regarding selecting appropriate performance-based tests, the data should capture the core of strengths and weaknesses in the spectrum of executive functions across contexts, to avoid assessments that focus on more limited, contextually restricted processes as opposed to those that tap on real-world, adaptive executive functions. To sort out this issue, there is need to develop ecologically valid assessment tools that

capture both (a) discrete elements of executive functions, as typically defined by clinical assessments, and (b) concrete aspects of the executive functions, as manifested in the child's everyday actions (Blair et al., 2016; Isquith et al., 2014; McCoy, 2019; Zelazo et al., 2016).

## **2.8 Identified Knowledge Gaps in the Literature reviewed**

Despite the large number of studies conducted and published on the role of executive functions in language and literacy development, there is still a dearth of literature focusing specifically on executive functions, focusing on Zambian preschool aged children in public schools. The following are some of the gaps that relate to the research design, type of digital media most used, age group, nature of the sampled population, gender and cognitive domain that have been addressed by the current study.

First, and foremost the studies examining the influence of technology on executive functions have exclusively focused on the influence of exposure to television rather than videos (Lillard & Peterson, 2011a; Yang et al., 2017) and yet it has been observed that children spend more time watching YouTube videos (Elias & Sulkin, 2017; Hourcade et al., 2015; Neumann & Herodotou, 2020; Yadav et al., 2018) than TV. This could be attributed to the considerable amount of time that TV has been in existence compared to computerised videos (Greenfield, 2014; Prot et al., 2012; Swing et al., 2010). The present study attempted to address this limitation by including action video games, rhymes and stories.

Second, most of the research on EF has focused on either adults or children from western contexts, which are affluent settings (Barac & Bialystok, 2012; Esposito et al., 2013). This observed biasness on the age group, context and the race of the studied participants is addressed in the present study. The majority of studies have focused more

on either very young children below three years or older. In order to address this gap, the current study focused on preschool children who fall within the age range when executive functions are rapidly developing. At the time of this study, no study of this nature seem to have been carried out in Zambia. This shows that there is need for studies that will investigate preschool aged children, drawn from a diverse cohort of children from all races and socio-economic backgrounds. The current study is a step in the right direction as it recruited Zambian preschool children from diverse socio-economic family backgrounds enrolled in public schools that offer limited learning infrastructure and resources when compared to the more enriched private preschools in Zambia.

Finally, while it has been widely reported that some typical children's specific components of executive functions (EF) such as working memory and cognitive flexibility tend to predict specific components of early reading skills, it remains unknown how inhibitory control is related to specific phonological awareness skills including rhyme awareness, especially that most of the studies on EF and phonological awareness have mainly concentrated studying English and not bantu languages like *Chinyanja*. The current study attempted to close this gap by studying the influence of EF on the link between the rhymes, stories and rhyme awareness in *Chinyanja*.

## **2.9 Summary**

The literature in this chapter began with evidence suggesting that, for preschool learners, executive functions develop with age especially in the inhibition and working memory domains. Next, a body of research on assessment of executive functions in preschool was discussed, showing the need to focus on behaviour rating scales for a meaningful assessment of executive functions in children. How different assessment approaches contribute to executive function development was then examined. The

review of literature discussed in this chapter shows that the role of executive functions in rhyme awareness has not been addressed in literature to the extent that is desired. The literature reviewed has shown that sub-components of phonological awareness proposed by Kenner and colleagues (2017) such as word awareness, phonemic awareness, sentence awareness and syllabication have been addressed in the literature except rhyme awareness. This area remains unexplored especially when it is linked to executive functions in preschool children. This neglect of rhyme awareness in the literature could be because most of the emergent literacy pedagogies in Africa use syllabication (Diemer et al., 2015; Probert, 2016).

Although there is considerable evidence in the three core areas that this review is focusing on that is executive function performance over time, approaches to executive function assessment, and the relation between executive function and rhyme awareness, little is known about the moderation role of executive functions in rhyme awareness interventions. The three factors that contribute to this moderation deserve attention. First, the development of executive functions in the Zambia preschools from low-resource communities and secondly, the contribution of the two testing approaches (performance-based and behavioural rating scales) to executive functions. The third factor is the relation between executive function and rhyme awareness in *Chinyanja*, one of the official languages of instruction in Zambia.

## **CHAPTER THREE**

### **THEORETICAL FRAMEWORK**

#### **3.0 Overview**

This chapter presents the theoretical framework, the lens from which the role of executive functions in moderating the association between an emergent literacy intervention composed of rhymes and stories, on one hand, and rhyme awareness on the other, is examined. There are four sections in this chapter. The first section examines phonological awareness theory from a developmental perspective demonstrating how rhyme awareness, an emergent literacy outcome of interest in this study develops in children. This perspective is presented to provide insight into how executive functions serve as a goal-between an emergent literacy intervention and rhyme awareness. The second section examines the theory that frames the current study. Specific underlying assumptions of Nesbitt's theory are explained including evidence in support of it, how it relates to the present study and the limitations inherent in the theory, which provide justification for the use of the proposed conceptual framework discussed in the third section.

#### **3.1 Theoretical Framework**

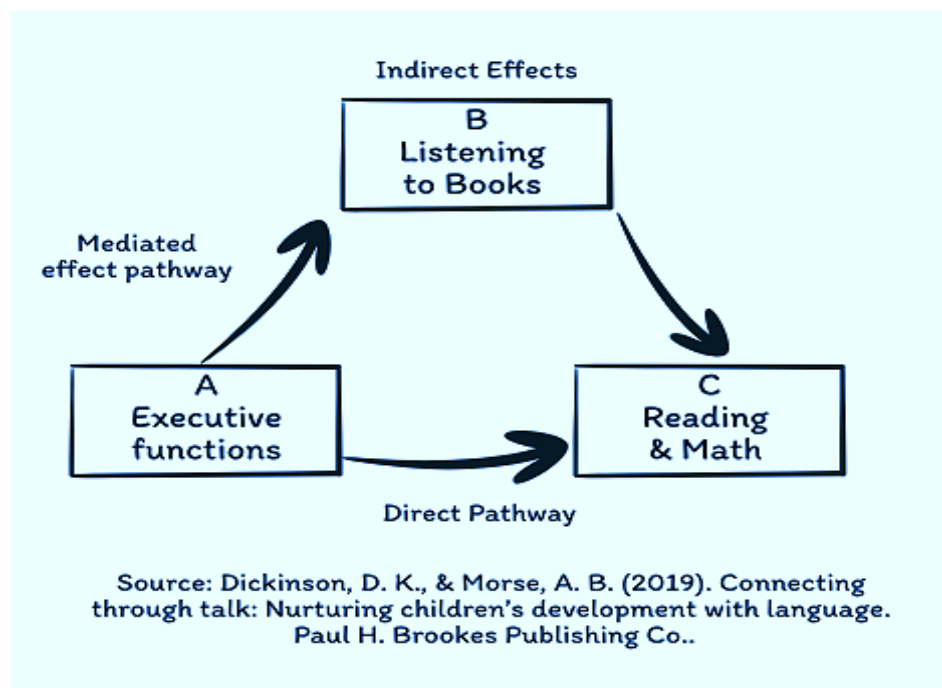
The current theory is located within the preschool development field and that is the reason for its use in this study that examined preschool children in Zambian public schools. For the past 3 decades, executive functions and academic achievement (EF-AA) theory developed by Nesbitt et al (2015) has been widely used to understand the relationship between executive functions and academic learning outcomes in preschool-aged children (Sasser et al., 2015). The current study applied this theory to explore the moderation role of executive functions in the relationship between an emergent literacy

intervention and rhyme awareness. Consistent with the EF-AA theory, executive functions have been found to influence varied learning outcomes such as the development of mathematics ability (Blair et al., 2016), reading comprehension (Meixner et al., 2019), emergent literacy skills (Blair & Razza, 2007; Farrar & Ashwell, 2012), letter and decoding (Fuhs et al., 2014), and word reading (Chung & McBride-Chang, 2011).

Although there is evidence pointing to the application of the theory in specified contexts (Booth, 2011; Cortés Pascual et al., 2019; Davidse et al., 2015; Meixner et al., 2019), not much research has been devoted to the role of executive functions in locally developed emergent literacy interventions in the context of this theory, especially among public preschools drawn from low socio-economic backgrounds in Zambia. Prior studies have used this theory in the context of Western preschool populations from high income families. The Executive Functions-Academic Achievement theory allows for better insights into the role of executive functions in emergent literacy interventions that have been locally organised in the Zambian preschool setting.

The Executive Functions-Academic Achievement theory (EF-AA) was an attempt to advance the idea that the degree to which children respond to learning opportunities in the classroom requires an understanding of executive function (EF) skills. This is because children with sufficient executive function skills would easily engage in learning-related behaviours, which place them at an advantage to seize the opportunity to the benefit of the classroom learning experience (Nesbitt, Farran, & Fuhs, 2015). The EF-AA aims at promoting executive functions to foster academic achievement (reading and maths skills) because EF predict both academic skills and learning-related behaviours in preschool children. The Executive Functions-Academic Achievement theory is illustrated in Figure 3

**Figure 3: Mediated Effects in the Relationship among Executive Functions, Learning-Related Behaviours and Learning Outcomes**



While executive functions are represented by letter A, learning-related behaviours such as listening to books are illustrated by letter B, and reading and mathematical abilities are represented by letter C. Executive functions (A) as shown in figure 3, predict both learning-related behaviour (B) and learning outcomes (C). Executive functions have a direct relationship with reading and math, while learning-related behaviours such as listening to books predicts learning outcomes (reading and mathematics). Learning-related behaviours mediate the relationship between executive functions and academic achievement in reading and mathematics. This suggests that a child's learning in the classroom may be influenced by the ways in which they behave. In the proved indirect pathway, EF skills provide skills that foster regulation of attention, inhibition, and memory in children who are more focused, attentive, and persistent in their classroom learning efforts (Sasser et al., 2015). Children's ability to make the most of classroom

learning opportunities is enhanced by the development of executive functions (Brock et al., 2009; Neuenschwander et al., 2012).

The executive functions-academic achievement model has been applied in a number of fields namely, preschool education, child development, cognitive neuroscience, child neuropsychology and also in adolescent research. Recently, this theory has been confirmed in three different contexts in Asia. Children aged 3-6 years old from Bangladesh, China, and India were investigated to test this theory and it was found that after adjusting for country, other socio-demographics and age, generally, EF was positively correlated with literacy outcomes. Specifically, working memory was significantly related to literacy in all the three countries (Rao et al., 2022). The theory was also practical in the Australian preschool context, where it was found that executive functions had a significant indirect effect on early academic achievement for non-Aboriginal 5-year-old children. Executive functions (EF) have been shown in a number of other studies to improve academic outcomes (Beisly et al., 2020; McClelland & Cameron, 2012; Welsh et al., 2010; Willoughby et al., 2012). It is worth noting that although EF are related to academic success, some reviews doubt if a causal relationship between the two exists (Jacob & Parkinson, 2015). Based on the overwhelming evidence that executive functions predict academic achievement, the executive functions-academic achievement theoretical framework informed the current study.

### **3.2 Existing Research on the Executive Functions and Academic Achievement (EF-AA) theory**

Although it has been established that children's adverse home environments, such as low socioeconomic status (SES), negative parenting and learning related behaviours have been linked to poor academic outcomes in early childhood, relatively little is known about other factors that affect academic outcomes apart from socioeconomic

status (SES), negative parenting and learning related behaviours. Executive function has been studied as a potential mechanism through which socioeconomic status and academic achievement are linked (Dilworth-Bart, 2012; Lawson & Farah, 2017; Micalizzi et al., 2019; Sun et al., 2018).

Poverty has been found to affect typical brain functioning (Allee-Herndon & Roberts, 2019; Finegood & Blair, 2017; Raver et al., 2013). This could negatively affect specific cognitive functions such as executive functions in children with lower executive function may have difficulties learning in school or even in other settings, which may be due to poverty (lower SES), which negatively affects brain structures associated with executive function (Dilworth-Bart, 2012). Children from higher socio-economic backgrounds are more likely to have access to resources that stimulate executive function compared to those from lower socio-economic backgrounds who may be subjected to deprived environments that are also stressful. This could impede executive function development (Dilworth-Bart, 2012).

Despite evidence on the role of executive functions in the relationship between socio-economic status and academic achievement (Beisly et al., 2022), it is not clear how executive functions moderate the relationship between rhymes, stories intervention and academic outcomes such as rhyme awareness. This study attempted to address this gap. One way of doing so was to look at this objective from the theoretical perspective provided by Nesbitt et al (2015). They argue that executive functions influence literacy and numeracy both directly and indirectly through learning-related behaviours. While this theoretical position has been supported, other prior studies have challenged it. Both viewpoints will be presented in the next section of this chapter. Prior studies supporting the theory will be discussed first and then those that do not support the theory will be examined.

Supporting the theory on the role of executive functions, Bohlmann and Downer (2016) found that children's initial skills in executive function were related to changes in their expressive language skills via their capacity to engage with classroom tasks and activities. The mediating role of learning-related behaviour on the relationships between EF and school readiness in literacy and mathematics was also supported by the work of Vitiello and others (2011) who conducted a mediating analysis to determine whether attention significantly mediated the relation between cognitive flexibility and school readiness in Head Start preschoolers. The study revealed that attention significantly mediated the link between cognitive flexibility and school readiness because cognitive flexibility could have an impact on children's readiness for school as it encourages the preschoolers to take different approaches to learning.

Among the studies that support the current theory is the study by Beisly and colleagues (2019). This study addressed both the direct and indirect links between preschool-aged children's executive functions (EF) and later, academic success by investigating relationships between EF, learning-related behaviours (LRB), and academic skills. This study confirmed the importance of EF and LRB for children's early academic skills, but did not provide support for a significant mediation role of LRB in the association between EF and academic skills. The results for this study add to the existing literature that provide empirical evidence for the current theory's dependability and validity for use in this study.

Recently, Beisly and colleagues (2022) studied the moderating role of executive function and learning behaviour in the relationship between socio-economic status of the family and children's academic outcomes. This study found that learning behaviour and executive functions played a moderating role that highlighted the potential for executive functions and learning-related behaviours to serve as a protective factor

against the negative effects of socioeconomic status on children's academic outcomes. This study added to and expanded upon earlier research by examining the moderating effect of preschoolers' learning behaviours on the link between socio-economic status and academic success. This provides support for the current theory being used in this study but does not account for socio-economic status. Instead, it caters for an emergent literacy intervention. Whereas the aforementioned studies provide evidence in support of the current theory, the next section presents equivocal evidence on the current theory.

In a study whose purpose was to determine if preschoolers at high risk for academic failure could be identified by analysing their EF growth trajectories over the course of their early childhood, Willoughby and colleagues (2012) found significant impairments in multiple indicators of academic readiness in delayed EF preschoolers compared to children with typical EF trajectories. Even after accounting for a wide range of socio-economic and cognitive (general intelligence screener, receptive vocabulary) covariates, moderate-sized group differences remained.

Similarly, Neuenschwander et al (2012) conducted a longitudinal study over the course of a year and found that while children's learning-related behaviours mediated the unique contributions of executive functions to academic success, this was a partial mediation. In addition, executive functions and not learning-related behaviours were the sole predictors of test scores in mathematics and reading. Sasser and others (2015) found that although academic functioning, and social competence were all significantly predicted by EF, the prediction was marginal for academic outcomes like literacy and there was no mediation between EF, and later, mathematics or academic functioning. In a study that differentiated hot and cool EF, Brock (2009) cool EF predicted math achievement, learning-related classroom behaviours but when compared to cold EF, hot EF was not predictive of any academic or behavioural outcomes.

The above studies provide mixed findings on the moderation role of executive functions in preschool children. One thing that can be said about these studies is that their findings cannot be generalised to the Zambian population because it differs in many ways from the population recruited for these studies. The following reasons for applying the EF-AA theoretical framework to this study are presented. First, this study utilised both performance-based and reported EF measures unlike prior studies that have only used teacher ratings of executive functions (Hooper et al., 2020). Second, there is need to apply this theory to the current study because of the cross-cultural analytic finding that EF (attentional control) was the strongest predictor of reading in Chinese and American preschoolers (Lan et al., 2011). These cross-cultural findings spark the interest to apply this theory to this Zambian study because prior studies have only investigated Chinese, Dutch and American Children (Thomas, 2016).

### **3.3 Application of the Executive Functions and Academic Achievement (EF-AA) theory**

The theory which frames this study as advanced by Fuhs et al (2015) is not only an influential theory but a timely contribution to the development of executive functions and emergent literacy in preschool children. This theory provides a perspective or lens with which various findings are integrated to explain the cognitive influence to emergent literacy via an intervention. This theory meets the criteria for a theory as proposed by Grant and Osanloo (2014), who argued that a theoretical framework emerges from an existing theory (or set of theories) in the scholarly literature that has been tested and verified in the field by many other scientists. The following are some of the different ways in which this theory is applied in the current study.

First, as an attempt to understand how executive functions influence the link between an emergent literacy intervention and rhyme awareness, the above theory

offers information on the relevant variables of interest such as executive functions and reading. These variables are the subject of this investigation. In support of the present study, the theory confirms that via learning-related behaviours executive functions are able to improve reading and mathematics outcomes in preschool-aged children. For the present study, the focus was similar in the sense that executive functions, rhyme awareness, a precursor to reading in preschool children were explored. While the theory generally examined literacy outcomes such as the ability to identify and pronounce alphabet letters, words, draw shapes, and write orally presented letters and words. The current study went further to examine rhyme awareness, which emerges much more earlier in childhood (Anthony & Francis, 2005).

Second, the theoretical framework is relevant for the present study because the use of both direct and indirect executive function assessments is evident in both this study and the studies from which this theory is developed. For instance, the studies from which this theory was tested used the following EF tasks: Corsi-block, Dimensional Change Card Sorting, peg tapping and the Copy Design to assess the three executive functions (working memory, inhibitory control and attention flexibility). However, the present study used a different set of executive function tests that include the pencil tapping, digit span, task orientation and the Stroop test. This is how the current study contributes to the knowledge gap created by the theory. This was done by selecting different tests from those used and validated in prior studies.

Lastly, like the sample from where the theory was developed, all the participants in this research were enrolled in free or low-cost preschool classes offered by the government of Zambia. The majority of the participants in the study came from low-income families. Similar to the studies from which the theory was built, in terms of teaching experience, preschool teachers in the sample had, on average, more than six

years of experience. The emphasis on public preschools offered by the government is interesting because of the large groups of learners and low teacher-pupil ratio, which strain the current classroom infrastructure in the Zambian preschool context (Kaunda & Ailwood, 2021).

### **3.4 Limitations of the Executive Functions and Academic Achievement (EF-AA) theory**

Although the executive functions-academic achievement theory has been established in the literature to explain how executive functions in preschool children directly and indirectly contribute to reading and mathematics achievement by examining a representative and diverse sample of 1,103 American children from 80 public pre-K children enrolled in 57 schools spread across 6 districts and drawn from low-income family backgrounds, this theory does not fully explain the role of executive functions as a moderator in the relationship between school-based rhymes, stories interventions and initial literacy outcomes like rhyme awareness due to the following reasons.

First, it cannot be generalised to the Zambian preschool context because the theory was developed from a limited sample of mostly, white American children whose educational exposure and language orientation is different from black Zambian children enrolled in public schools, which are deprived of teachers, learning materials and appropriate literacy instruction (Hestad et al., 2016; Mulenga et al., 2001; G. Tambulukani & Bus, 2012).

Second, the theory does not account for how executive functions influence emergent literacy interventions to improve rhyme awareness. What this theory does very well is to explain the role of executive functions (EF) in mediating the relationship between learning related behaviours and emergent literacy and mathematics. However, others have found no such link between EF and academic success through the mediation

of learning-related skills. Additionally, no significant mediating role for learning-related behaviours exists between EF and emergent mathematics in a sample of kindergarteners (Brock et al., 2009). It is not doubted that EF plays a significant role in how well preschool learners perform on emergent literacy and numeracy tasks (Mulder et al., 2017; Sasser et al., 2015; Welsh et al., 2010). What is convincing is that the association between EF and academic skills appears to be more direct than indirect, although there is evidence that learning-related skills mediate the relationship between EF and academic skills in young children (Fuhs et al., 2015; Sasser et al., 2015). There is now a need for a theory that would explain the role of executive functions in moderating the relationship between the targeted intervention and rhyme awareness as a specific outcome for academic achievement.

Third, the current theory does not provide for the role of potentially confounding variables such as parental education, oral vocabulary, intelligence, home literacy environment (because the theory was tested on a school-based sample) and language. The question then is, would the findings on which the current theory is based be different if confounding variables were controlled? Socio-economic variables need to be adjusted in most studies because they tend to exert more influence on learning outcomes compared to school intervention programmes and curriculum (Tonér & Gerholm, 2021; Zach et al., 2017).

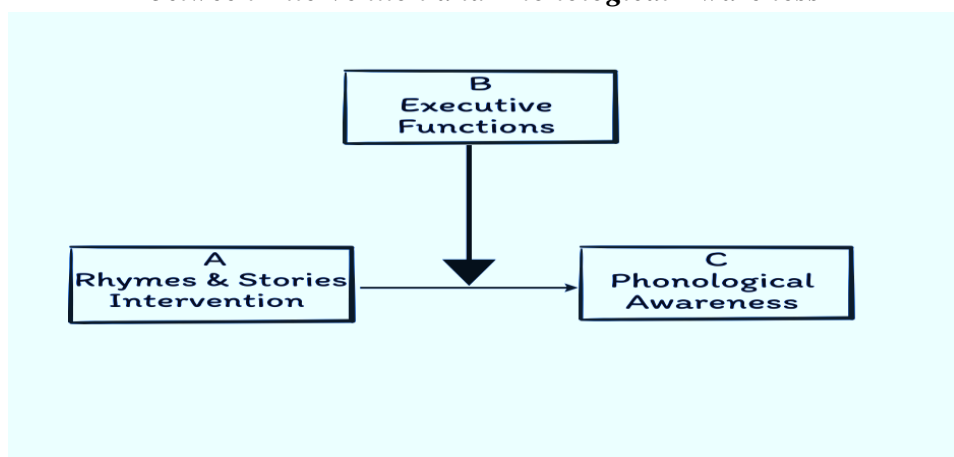
Finally, the current theory is based on domain-general outcomes such as academic achievement as assessed using seven scales from the Woodcock-Johnson III Achievement Battery (Woodcock et al., 2001) and not domain-specific emergent literacy such as rhyme awareness, the most basic phonological awareness component as measured by rhyme recognition, picture rhyming and rhyme production (Cameron et al., 2012). To address this limitation, there is a call for attention on intervention

studies that focus more on basic emergent literacy skills such as rhyme awareness than advanced phonological awareness outcomes such as alliteration, onset-rime, segmentation, blending and word deletion and manipulation (Schuele & Boudreau, 2008). The following proposed conceptual framework as assessed in this study attempts to address the limitations of the current theory explained earlier.

### 3.5 Proposed Conceptual Framework

To address these limitations, the current study hypothesised the following. First, learners perform better on executive function tasks from preschool to Grade One. Second, EF predicts phonological awareness skills. Third, EF direct measures will strongly predict phonological awareness skills compared to EF observational measures. Finally, EF will moderate the relationship between the rhymes, stories intervention and rhyme awareness skills. This model was named the executive functions-phonological awareness moderation model (EFPAM) as shown in Figure 4 below.

**Figure 4: Conceptual Framework: Executive Functions Moderates the Relationship between Intervention and Phonological Awareness**



This study examined whether EF would moderate the relationship between the rhymes, stories intervention and phonological awareness skills. In Figure 4, the intervention is represented by A, executive functions by B and phonological awareness skills by C.

From among the numerous theories of executive functions development existent in the literature, the theory proposed by Nesbitt and colleagues was selected to be appropriate for the current study due to the following three reasons. First, this theory's underlying emphasis on the development of reading as influenced by executive functions in childhood resonates very well with the current study's focus on executive functions moderation role in initial literacy outcomes in preschool. Second, the theory's wide application in several contexts encouraged the researcher to use this theory to guide and inform the present study. Third, this theory was used to explain why this study was needed for this specific targeted population and why it was important. Furthermore, the theory used in this study exhibits sufficient academic rigour in line with the guidelines provided in the wider field of preschool education. Finally, executive functions are essential for language and literacy development (Sesma et al., 2009; Zelazo et al., 2016) and qualify to be the most studied cognitive skill in the last decade (Cortés Pascual et al., 2019). It is not clear how the EF-AA theory can be applicable to the Zambian preschool context. The present study attempts to provide a solution to this literature gap by extending this theory to the preschool aged children from deprived settings.

If successfully applied to the Zambian public preschool setting, the proposed hypothesis provides support for the link between young children's knowledge of rhymes, stories and their ability in learning about written language. It is true that exposure to rhymes and stories heightens children's sensitivity to the individual sounds in their language, which, in turn, influences how well they read and spell. This argument is entirely supported by previous work (Bryant et al., 1990; Goswami, 1999, 2002b; Hatcher & Hulme, 1999; Kirtley et al., 1989). Additionally, to support previous findings, we require data from intervention research like this one to offer more evidence

for this theory. If our theory is correct, then more exposure to local digital rhymes and stories should help public pre-schoolers in Zambia to learn to read and spell as well as to improve their performance on phonological tasks.

### **3.6 Summary**

To adequately understand the role of executive functions in emergent literacy, an indirect pathway was explored in which the relationship between an emergent literacy intervention and rhyme awareness was moderated by executive functions. The theoretical perspective offered by Nesbitt et al., (2015) was used to as a framework on which the present study was anchored. The theory helps to make it clear that children who performed better on EF tasks were more engaged and less disruptive during the intervention. This suggests that children's developing rhyme awareness abilities were indirectly affected by the learning-related behaviours demonstrated during the intervention and directly by executive functions, which facilitate skills for learning rhyme awareness tasks.

## **CHAPTER FOUR**

### **METHODOLOGY**

#### **4.0 Overview**

This chapter will address the following key questions. First, how was the data collected cleaned and measured? Second, how was the data analysed? In this chapter, the methods, procedures and materials that were used in the study will be discussed. First, a description of the nature of the research design and participants will be provided then the procedures that were followed in the experiment will be explained. The data collection instruments used in the experiment will be described and this will be followed by a discussion on the specific statistical analysis tools employed.

#### **4.1 Research Design**

A between-subjects experimental design was used because of the specific hypotheses that were tested. In other words, the particular hypotheses that were tested in this study determined the choice of this design. This design offered more internal validity by preventing practice effects and offering shorter sessions. In this design, participants were randomly assigned to either an experimental or control condition (see Figure 7). This study had two control groups and one experimental group. The experimental group was exposed to digital rhymes and stories that the research administrators believed would have some effect on their literacy outcomes, while one control group was engaged in free play, the second control group played an action video game that was unrelated to the digital stories and rhymes.

This specific research design was chosen for the following three reasons. First, the research design provides comprehensive techniques of examining the hypotheses in

this study. Second, this experimental research design was used because this research design offers a rigorous method of examining the effect of executive functions on emergent literacy development. Third, empirical and analytical methods, under which the current study design falls, tend to assume an objective stance where knowledge is acquired through experience. For instance, conclusions can be drawn by focusing on experiences acquired through interacting with children and their eventual interaction with the intervention that was provided. Finally, the current between-subjects design was chosen based on three considerations: statistical, methodological and theoretical reasons. In terms of statistics, the design allowed for a high statistical power and quicker administration of the intervention. Methodologically, between-subjects' designs avoid fatigue and practice effects, which happen when participants become bored during the study. Theoretically, the between-subjects' design permitted effective testing of the study hypotheses.

## **4.2 Participants**

In the current study, 375 preschool participants enrolled in 14 Lusaka Province public schools were investigated. This sample was drawn from the population of preschool children enrolled in government schools in the three districts of Lusaka province. As shown in Table 3, the participants' age was on average 81.09 months, the standard deviation of the age was 15.69. In terms of sex distribution, 48% were boys and 52% were girls. The majority (73%), spoke *Chinyanja*, while the rest spoke other languages (27%). The means and standard deviation for the home possessions index were  $M=7.95$  and  $SD= 2.02$ . The study was carried out in three districts of Lusaka Province, namely, Lusaka, Chilanga and Kafue districts. The three districts were selected out of the six districts of Lusaka Province because of they were similar in terms of the demographic

characteristics such as nature of preschools, size, language use and student performance-based on Examination Council of Zambia national assessments and location.

Using the between-subjects design, the study examined potential effects of executive functions on the rhyme and stories intervention's influence on phonological awareness (rhyme awareness) of Zambian preschool children enrolled in public schools. The study examined the role of executive functions in moderating the relationship between the rhymes, stories intervention on one hand and rhyme awareness as the targeted outcome on the other hand. Children were randomly assigned to one of the three conditions: intervention (rhymes and stories), or the two active control conditions (action video games or free play). The rationale for setting up these conditions relate very much to the need to have two control groups that were exposed to non-literacy stimulating material so that the only literacy gains could be attributed to the targeted intervention materials, in this case the rhymes and stories.

Preschool aged children were chosen for the present study because of the following reasons. First, public preschool education in Zambia was still in its infancy at the time this study was conducted (Munsaka & Kalinde, 2017; Mwaba et al., 2016). For this reason, not much was known about this sector of education in Zambia. Second, preschool children's exposure to technology-enhanced devices such as phones and tablets continues to grow in Zambia, even when there are limited studies that investigate the effects of technology on the cognitive development (Anderson & Subrahmanyam, 2017). Finally, preschool children were recruited in this study because a lot of children were enrolled in public preschools at a time when there was limited learning and teaching resources in these schools. The dynamics of how novice learners would

navigate their learning experiences became important to document in the Zambian literature (Yang et al., 2017).

### **4.3 Intervention Materials**

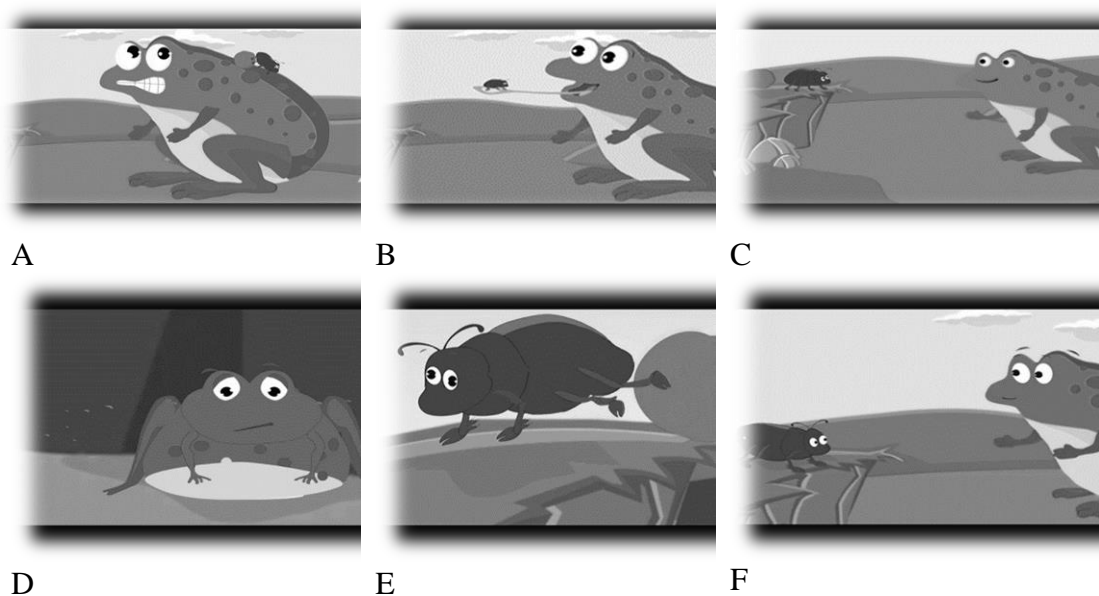
#### ***Intervention Condition***

The participants in the intervention condition watched 4 animated Chinyanja stories and 7 rhymes. The duration of the stories and rhymes used in the intervention and the number of words in them are shown in Table 1. Most of the story content included words used in the Zambia preschool curricula, which are consistent with other children's picture storybooks that are available in Zambia and were both age and culturally appropriate. Participants were exposed to these digital stories and rhymes 4 sessions per week for 24 sessions in a 6-week period. The participants first watched the stories and then the rhymes on a portable 7 inches tablet computer with headphones. The participants watched the stories and rhymes during the time that other participants in other conditions were engaged in either free play or action video game activities. These intervention materials were all arranged in the same order for all participants. The following section describes the full details of the stories and rhymes used in the intervention.

***Digital Stories:*** An example of one story that participants watched is *The Frog and the Beetle* (translated as *Cule ndi Kamkhunkuniza*) that was adapted from the story of the Lion and Mouse (Lotherington et al., 2008). In the story, a frog was asleep on one sunny day. The beetle came out to play and climbed on top of the frog's neck and slid down his back. The frog caught him with a great big smack! 'I'm going to eat you! Why are you disturbing my sleep' the frog said, his mouth opened wide? 'Oh no, no, please don't!' cried the beetle. 'Be kind to me maybe one day, I could help you.' 'I'm a frog!

You're a beetle! What can you do to help me?' The frog laughed and let the beetle free. On another day, the beetle was out walking. He heard a sound of a grumbling frog, and peeped when he saw the frog stuck in a deep ditch. The beetle then developed a plan to set the frog free. The beetle worked quickly and dropped cow dung in the ditch that helped the frog to step on the cow dung so that he could easily jump out of the ditch. The frog said, "Oh little beetle, I had no hope of being rescued. You were right, beetle – thank you, I'm now free. You are now my best friend" (See Figure 5).

**Figure 5: *The Story Cule ndi Kumkhunkuniza* (scenes run from top left A to F)**



**Digital Rhymes.** An example of a 63 seconds-long rhyme (17 words) used together with other digital stories took the form of a *Chiyanja* rhyme designed in a dialogic fashion, which could be translated as follows: ‘At my grandmother's village, there are lions, one lion, many lions, there are male lions and female lions, there are older lions and younger lions, where are the lions seated? They are seated under a tree’.

The following are the actual Chinyanja words that were used in the rhyme:

*Kumunzi kuli agogo*

*Kupezeka mikango*

*Mukango, Mikango*

*Mikango zimuna, Mikango zi kazi*

*Mikango zikulu, Mikango zi fana*

*Mikango za nkala kuti?*

*Munyansi yamu mtengo*

Participants were repetitively exposed to episodes of the word *Mikango* (several Lions) with the same end sound as *Mukango* (single lion) and *Mtengo* (tree). The rhyme progressed to more words, which had similar end sounds like *Muna* (male) and *fana* (young). All the rhymes were narrated in the same voice. The type of stimulus that accompanied the oral and written text, showed the wagging tails of the lions and the rocking chair of the grandmother to illustrate the active part of the video. Background music was included in the video and attractive visuals such as vegetation in the background of the video (See Figure 6) in order to dramatize the rhyme details and scenes and to avoid distractions.

**Figure 6: The Rhyme Kumunzi Kuli Agogo (scenes run from top left A to G)**



A



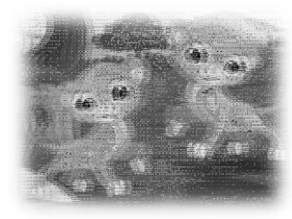
B



C



D



E



F

All the rhymes were originally created by the research administrators on account of the absence of such nursery rhymes at the time of the current study in 2017. Initially, 10 rhymes were created. After the pilot study, 3 rhymes were discarded due to non-compliance to guidelines proposed by Mayer (2021) on short videos for children. Development of these digital rhymes and stories was consistent with the general educational principles for making digital materials for language and literacy development (De Jong & Bus, 2003; Mayer, 2021; Korat & Shamir, 2004; Shamir & Korat, 2006, Mayer, 2001, 2009).

These quality assured *Chinyanja* digital stories and rhymes were used for two main reasons, First, as earlier stated, because they were among the few available learning resources for Zambian participants in the local language of instruction (Kessy et al., 2006; Mwanza & Mkandawire, 2020). Second, the non-digital equivalents of these stories, published by the Cambridge University Press were successfully implemented by the Rainbow Reading Library, a project of the Ministry of Education, Zambia co-

ordinated by Primary Reading Programme (PRP) in all the seven Zambian official languages countrywide (Massanzi, 2011).

The rhymes were developed by the research administrators in collaboration with highly experienced and qualified public preschool teachers and language experts from the University of Zambia, School of Education. In the process of developing the stories and rhymes, the research administrators consulted the Zambian Early Childhood Education (ECE) syllabus and textbooks approved by the Ministry of Education and the Curriculum Development Centre for use in Zambian preschools. Another quality assurance process was to ensure that the stories and rhymes were language appropriate. Thus, local language experts reviewed the stories and rhymes and provided feedback which was used to further refine the materials before implementing them. The stories and rhymes were piloted twice among preschool children in Kalingalinga to ensure that the words and the pictures were well-understood.

**Table 1**

*Stories and rhymes used in the intervention*

	No. of words	Duration (seconds)
<b>Stories (4)</b>		
<i>Cule ndi kamkunkhuniza</i>	80	88
<i>Ukonde</i>	72	63
<i>Piko</i>	44	48
<i>Zipatso ndi Zamasamba</i>	171	140
<b>Rhymes (7)</b>		
<i>Patu</i>	35	36
<i>Tumbewa</i>	78	81
<i>Amalume ndi mbalame</i>	37	40
<i>Cithunzi-tunzi</i>	69	68
<i>Cona</i>	58	55
<i>Fisi</i>	39	35

The animated stories and rhymes contained background sound so that the participants' attention and the emotions could be captured. For example, the sound of a disturbed frog crying in the story of the *Frog and the Beetle* aroused sadness and attention. Including background sound that enhance the story comprehension, is effective in auditory stimulation and may have additional advantage for multimedia learning. Background sounds that are contingent with the oral text enable simultaneous processing of both visual and audio material to enhance story comprehension (Eggleston et al., 2021, Bus et al., 2015).

**Action video games control 1 condition:** The other experimental condition included the action video game condition. This group of participants played one popular endless runner video game on a portable 7 inches tablet computer with headphones for a period of 12 minutes. This game started by clicking on the start button on the tablet touch screen, the game was about either a young boy or girl who, upon being seen in the act of getting gifts from Santa Claus's gift bag in a metro railway site, runs down the railroad tracks to escape from a white-bearded Santa Claus who exclaimed "you (referring to the young girl or boy), run". Santa Claus starts chasing the boy or girl. As the boy or girl is running, the player swipes up, down, left, or right to avoid crashing into oncoming obstacles especially moving trains, poles, tunnel walls and other barriers. By swiping rapidly and attentively as the game speed increases, more points are accumulated. The game was over when the player hit into one of the oncoming obstacles and was picked up by Santa Claus. During the game, the player was rewarded for each successfully accomplished level by collecting various rewards such as coins, score multipliers, sprinting sneakers, jetpacks, magnets, gift boxes and scooters (Jiwal et al., 2020). This condition was used as an active control group in the present experiment.

*Free play control 2 condition:* During the time when the participants in the experimental groups were exposed to the rhymes and stories, those in the free play group engaged in various routine play activities. The free play group was engaged in their usual unsupervised play where they go out to the play ground to interact with other pupils. This was the second control condition of the experiment. In this condition, the children engaged in preferred play activities (unstructured play). There were no external goals set by either the researcher or the teachers on how the children could play.

#### **4.4 Sampling Procedure: Simple Random Sampling**

Because the participants in the target population did not differ significantly in terms of geographic location, sex, parents' educational level, and age, simple random sampling was utilised in this study. After obtaining ethics approval, the participants' parents were informed about the study; willing parents made an appointment to come to the participant's school to sign informed consent forms where the study was described in detail. All the participants who met the following two inclusionary criteria were randomly selected and assigned to the specific conditions. The first criterion was based on the maximum number of enrolled preschool learners in each school. Here the preschools are selected. and the second criterion was based on the need to effectively monitor the intervention. As for the first criteria, schools submitted class lists, which were used to simple randomly select the participants. Simple random sampling has been recommended by most of the studies that used between-subjects research design. This was done by writing the participant's names from the class list individually on pieces of paper, which were wrapped up to hide the details, and were placed in a bag. Thereafter, 15 or 30 participants' names depending on the number of participants in the class were picked from the bag. The selected participants' names took part in the study.

The second criteria involved selecting only public preschools that were located within 10km of each district's education administration centre. The public preschools that met these criteria were included in the study. The criterion stated earlier is what was used to select public preschools in each district.

The random assignment of participants to the three conditions was done after the pre-assessment. In each school, equal numbers of participants were randomly assigned to each of the three conditions mentioned above. For instance, in schools where 30 participants were randomly selected, 10 were assigned to the experimental condition, 10 to the first control and another 10 to the second control. Simple random sampling was used in assigning participants to the three conditions. This was done by writing each participant's name on separate pieces of paper. These pieces of paper were placed in a box, and the research administrators did the random assignment as follows: every first participant's name selected from the box was assigned to the experimental condition, every second participant's name was assigned to the first control condition, and every third participant's name that was selected from the box, was assigned to the second control condition.

Permission to access the schools was granted by the provincial and district education office within the Ministry of Education in Zambia. Once permission by the head teacher was obtained, all the participants who met the inclusionary criteria were randomly selected and assigned to the specific conditions as described below.

The intervention took place within the school in a separate room away from the classroom. In each preschool, the two groups, one with digital rhymes and stories and other with digital games, used the same room. However, these were arranged in such a way that these two groups sat opposite each other across the classroom in order to prevent the groups from being exposed to the materials that the other group was

engaged with. Both the digital rhymes and stories and the digital non-literacy games were presented on individual tablets, and both groups were exposed for the same period of time; 12 minutes. The third group that was not exposed to anything continued with other classroom activities. It should be noted that the intervention was planned to be conducted during the free play time as scheduled on the classroom time-table. The 6-week intervention took place during the class time scheduled for free play. This time was opted for in order not to disturb the routine classroom learning activities.

#### **4.5 Double Blinding of Participants**

In order to reduce on any sort of bias and enhance internal validity during the data collection process, all the assessors, research assistants and research administrators including the participants, were double-masked to experimental conditions. This is consistent with practice in experimental research. A research administrator assigned to work in one district to assign participants into the experimental groups, did not work in another district. For instance, the one who earlier worked in Chilanga district assigned participants to different groups in Kafue district, and the one for Lusaka district assigned participants in Chilanga district. This double-blind withheld each participant's group assignment from both the participant and the researcher performing the experiment. At the post-test level, researchers and data collectors switched districts, and were only given the list with the random selection of participants and not the lists with random assignment of participants. Post-test data was collected without any knowledge of each participant's group assignment.

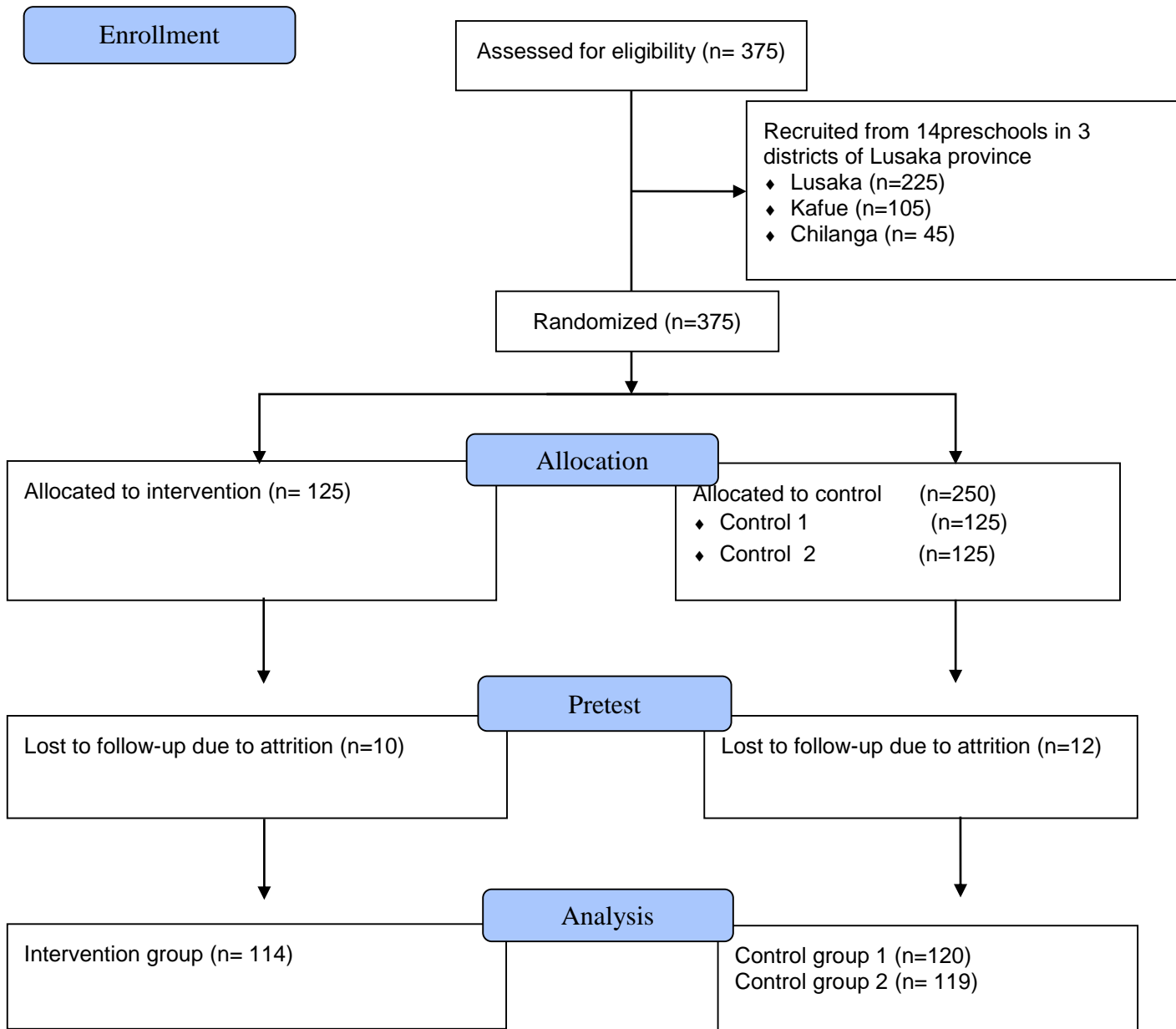
#### **4.6 Data Collection**

Data was collected in two stages, pre-assessment and post-assessment. During pre-assessment, the research administrators with the assistance of trained research assistants collected the data. The pre-assessment was conducted over a period of three weeks. All tests were administered to individual participants. Test administration took place in the schools. In order to reduce distractions, an office space located within the school premises was specifically designated to conduct the tests. During the pilot study, it was established that testing took about 60 minutes to complete for each child. In order to reduce participant fatigue during testing, each participant was tested in two separate sessions, each session lasting 30 minutes. Pre-assessment items for session one and session two were clearly marked so that each examiner would know where to stop for the first session. The order in which the tests were administered was the same for all participants. The first session had the following tests; letter knowledge, letter-sound identification, familiar language test, rhyme recognition test, picture rhyming test and rhyme production test. The second session had the Rapid Automatised Naming test (RAN), Expressive One Word Picture Vocabulary test and the Receptive One Word Picture Vocabulary test.

The second stage of data collection was post-assessment, which commenced one week after the 6-week intervention was completed. During the post-assessment, data was collected by the research administrators with the assistance of trained research assistants. The post-assessment was conducted over a period of three weeks. All tests were done individually and took place in the schools. In order to reduce distractions, an office space located within the school premises was specifically designated to conduct the tests. Each participant was tested in two separate sessions and each session lasted for 30 minutes. Post-assessment items, like the pre-assessment items for session one

and session two were clearly marked so that each examiner would know where to stop for the first session. The order in which the tests were administered was the same for all participants. The first session had the following tests: letter knowledge, letter-sound identification, familiar language test, rhyme recognition test, picture rhyming test and rhyme production test. The second session had the Rapid Automatised Naming test (RAN), Expressive One Word Picture Vocabulary test and the Receptive One Word Picture Vocabulary test.

**Figure 7: Participant Recruitment Process**



#### 4.7 Measures

The following section describes the instruments that were used to measure the relevant constructs. These instruments included both standardised and self-developed tests and their reliability statistics indicated in Table 2.

#### **4.7.1 Executive Functions Measures**

Although, different standardised childhood executive functions measures have been investigated, many of these tests are not culturally appropriate (developed and often used in high income and individualistic cultural contexts). In view of this limitation, culturally appropriate and validated executive function instruments were used for the following reasons. First, the measures have strong psychometric properties. Second, the tests were developmentally appropriate, child-friendly and they were also not difficult to administer to young participants in the preschool context that was used.

Third, short term memory capacity is usually measured with span-type tasks in which the child must engage in immediate processing while retaining information for either instant or later recall (Cockcroft, 2015a). However, this is a simple span task that measures simple, short-term memory span and not working memory. This task requires immediate recall of information with no additional processing. The child received an outcome score for each correctly recited string of digits for a maximum of 39 points. Higher scores on the forward tasks indicated greater short-term memory capacity (Cockcroft, 2015b).

Finally, the current study utilised these tests because they were designed to be relatively unaffected by environmental factors such as the quality of social and intellectual input in the home environment, rural or urban living conditions, socio-economic status (SES), or preschool attendance (Alloway et al., 2004; Rindermann et al., 2010). This could be one of the reasons for its prior use in the Zambian context. The digit span forward task has been shown to be reliable in prior research (Müller et al., 2012).

Sustained attention was measured using the Task Orientation rating scale, inhibitory control was measured by an adapted version of the Stroop-like task (SLT)

also referred to as the Opposites Stroop task, short-term memory was measured using the digit span forward subtests of the Wechsler Preschool and Primary Scale of Intelligence-III (WPPSI) and inhibitory control were assessed by the pencil tap task similarly to how they have been used in prior research (Kegel & Bus, 2014; Mwanza-Kabaghe, 2015a).

***Task Orientation Rating Scale.*** At the end of each assessment battery, examiners completed a four-category rating of the perceived child's behaviour and ability to pay attention, focus was placed on the given tasks of the data collected (0 = Child spends most of time off-task, inattentive, was unable to pay attention, was not engaged in task, 1 = Child's attention frequently drifts and requires frequent prompts, 2 = Child's attention occasionally drifts, particularly at the end of activities, but is responsive to prompts, 3= child looks closely at pictures to distinguish between them. Child attends to and complies with interviewer). These ratings reflected the examiners' subjective impressions of participants' understanding of task instructions, engagement with the task, and the suitability of the testing environment. The task orientation scale was designed to measure executive function, compliance and attention as rated by the child examiner. The scale has been shown to be predictive of both cognitive and socio-emotional outcomes as well as executive function measures, and was validated in Zambia (Fink et al., 2012), Kenya (Willoughby et al., 2019) and the United States of America (Smith-Donald et al., 2007). The scale is a promising ecologically valid EF measure because of the Cronbach's alphas that have consistently been reported to be above 0.85 (Fink et al., 2012; Smith-Donald et al., 2007).

***Opposites Stroop-like Task:*** participants were instructed to tell the researcher the opposite of the picture as fast as possible when a specific picture was randomly presented to them on a tablet computer power point slide. Tablet computers have been

found to be more interactive than traditional computers (Willoughby et al., 2019). Thus, participants were required to inhibit a natural automatic response (e.g., the participant had to say “fat” when presented with a picture of a “thin” clown and “girl” when shown a picture of a “boy”) when faced with a salient conflict in order to produce a non- natural response (e.g., saying “thin” when shown a picture of a “fat” clown, saying “girl” when shown a drawing of a “boy”). There were 45 slides split across four conditions and each slide lasted for 2 seconds. 15 practice slides were presented to the participant before the main test slides. The number of correct responses was used as the outcome score. The task put different demands on working memory and inhibitory control of the most obvious responses. Pre-test reliability coefficients for most scales were high (0.80–0.94). This test had ecological validity because it had been used in prior Zambian and Dutch studies (Kegel & Bus, 2014; Mwanza-Kabaghe, 2015a). There is a huge amount of literature that supports the use of Stroop tasks as reliable measures of inhibitory and interference control (Lagattuta et al., 2011; Ling et al., 2016; Mikaela, 2021; Montgomery & Koeltzow, 2010).

***Digit Span Forward Task (DSFT):*** Short-term memory was assessed using the forward subtest due to the ceiling effect recorded by backward subtest during the present pilot study and reported elsewhere among preschool participants (Davidse et al., 2015; Tonér & Gerholm, 2021). During the DSFT, participants were instructed to repeat each digit sequence spoken by the examiner in the correct order. The task began with a training phase in which the participant was read 2-number strings, which gradually increased to trials of 9- number strings each in the last block. The participant had to recite the string forward (Lillard & Peterson, 2011b). For example, if the examiner said “2, 6,” then the child was expected to say “2, 6.” The test consisted of 9 blocks of 2 trials each. The test started with one practice item of two numbers similar

to the first level and increased with one number every next level. If participants correctly recalled two trials in the same order in a block, the examiner increased the span requirements by moving onto the next block with more digits than the previous one. If the child failed two trials in a block, the test was discontinued. The score was equal to the number of correct responses. The forward digit span task measures short-term verbal memory (Tonér & Gerholm, 2021) and working memory (Conway et al., 2005; Diamond, 2013; Gathercole et al., 2003) and was found to be reliable in the current study (alpha reliability score = .70).

***Pencil Tap (PT)***: The pencil tapping task, adapted from Luria's tapping was used to measure sustained attention in which participants were required to tap a pencil on the desk, a predetermined number of times in response to the examiner's taps (Diamond & Taylor, 1996). For instance, the examiner was required to tap the opposite number of times that the examiner tapped, the child was required to respond by tapping twice (when examiner tapped once), once (when the examiner tapped twice) and the child was not supposed to tap the pencil when the examiner tapped it three times. The task was conducted with predetermined delays between items. Participants were given three training sessions before the actual test was administered. This test was earlier used in Kenya (Brooker et al., 2010) and validated in Zambia (Fink et al., 2012; Matafwali & Chansa-Kabali, 2017) as a test of attention and memory in childhood. Participants were tested individually by first giving them 3 practice exercises before the actual test was given. Several different versions of this test exist such as the peg-tapping test used for assessing inhibitory control among preschool participants, found to possess strong psychometric properties. Cronbach alpha was .82 in preschool participants (Blakey & Carroll, 2015; Diamond & Taylor, 1996).

**Table 2: Psychometric Properties of the Measures**

Measure	Range	Cronbach's $\alpha$
Stroop-like task	0 – 36*	
Forward Digit Span	0 - 12	.71
Pencil Tapping task	0 - 40	.94
Task Orientation	4-39	.92
Chinyanja receptive test	1-25	.77
Chinyanja expressive test	0-11	.77
Rhyme production test	0-15	.85
Picture rhyming test	0-17	.79
Rhyme recognition test	0-19	.73

\*outcome score was calculated from the time taken to complete task in seconds. This could not afford calculation of the Cronbach alpha

#### **4.7.2 Phonological Awareness**

In order to assess phonological awareness and vocabulary, the following three measures were used: rhyme production, rhyme recognition, and the picture rhyming tests.

**Chinyanja rhyme production test:** Rhyme production was measured by asking the participant to identify words that had the same end sound. After two practice items, the participant was instructed to identify same ending words: examiner said “Tell me a word that rhymes with *gona*” (nonsense words were accepted). “Now tell me a word that rhymes with...”

**Chinyanja rhyming picture test:** This test was used to measure the participant's ability to produce two rhyming words. The child was asked to look at four pictures from which the child was supposed to say two names of the pictures that had the same sound at the end. The examiner said: “have you seen the pictures here? Using one sound, can

you tell me what you are seeing is happening.” After the child had successfully named the items, the examiner asked the child: “can you tell me which pictures have the same sounds?” Incorrect responses were indicated if the child did not successfully name the four pictures of either the nouns or verbs.

**Picture rhyming test:** The participant’s ability to identify pictures with rhyming words was assessed in this task. The test had four full colour pictures. Two of the pictures had words that had the same end sound while the other two pictures were distractors. Participants were shown the pictures on a 7-inch tablet computer and after three practice items, they were asked to examine the displayed pictures and asked to say and point to two pictures that had the same end sound. Non-target pictures were phonologically similar to the target picture and were semantically related to the target picture. A point was awarded for a correct response and a zero for incorrect response.

#### **4.7.3 Vocabulary Measures**

The following four measures were used to test both receptive and expressive vocabulary: *Chinyanja* expressive one-word vocabulary tests, Peabody Picture Vocabulary Test (PPVT), familiar language test and the *Chinyanja* one-word picture receptive vocabulary test.

***Chinyanja expressive one-word vocabulary test:*** This test was used to assess participant’s ability to express themselves orally. The child was presented with four pictures on the tablet screen and was instructed to say the picture that most closely shows the meaning of the word. After the child says the word, another set of pictures will appear with the next item. Four sample items are provided at the beginning of the test to orient the child to the task. The criteria for selecting distractors for this test were as follows: First, all the items were familiar to participants across a range of socio-

economic and Zambian cultural backgrounds. Second, they were phonologically similar to the target picture and semantically related to the target picture.

***The Peabody Picture Vocabulary Test (PPVT):*** was used to measure the pupils' receptive language. The PPVT is a non-verbal language assessment tool. It was adapted to the Zambian context by removing culturally unsuitable items and was translated into the local language. It is meant to test the pupil's knowledge of common items found in the environment. In this tool, the child is shown groups of four pictures and the child is then asked to point to the one representing the meaning of a spoken word described by the examiner. The Peabody Picture Vocabulary Revised version was translated into *Chinyanja*, the test consisted of 30 items which were adapted to the Zambian context.

***Familiar language test (FLT):*** This test measures expressive vocabulary based on different individual picture items. Participants are individually asked to look at the picture and name the item or action in the picture in the Zambian language. This was adapted from the FLT used by Tambulukani (2015). When the participant is engaged in the explanation of this task, the examiner carefully listens to the vocabulary the child uses, and ticks against words used that are on the score sheet under the appropriate language.

***Chinyanja one-word picture receptive vocabulary test:*** This test measures receptive vocabulary knowledge. The child is presented with four pictures on the tablet screen and the examiner says a word. The child is instructed to touch the picture that most closely shows the meaning of the word. After the participant makes a choice, another set of pictures appears with the next item and associated spoken word by the examiner. Four sample items are provided at the beginning of the test to orient the child to the task. The criteria for selecting distractors for this test were straightforward: First,

all the items were familiar to participants across a range of socio-economic and Zambian cultural backgrounds. Second, phonologically similar to the target picture and semantically related to the target picture. The Chinyanja receptive test, *Chinyanja* expressive test and the familiar language test, were factorised into one variable.

#### **4.8 Quality of Measurements**

Recruitment and training of research assistants: In order to have a committed and efficient research team, a group of motivated research assistants were recruited who met the set application criterion that included 12 years of education and a minimum of a college qualification, prior experience working with young participants and proficiency in the school language of instruction in Kafue, Lusaka and Chilanga and expressed interest and commitment to be available for the duration of the project. The research assistants were recruited three weeks before the commencement of the training, pilot and main study. This timing enabled the researcher to know their (research assistants) schedules in good time and this made the planning of the study easier.

During the four-day training of research assistants, issues such as the rules and regulations of the research project, general introductions, expectations, the main purpose of the study, and general duties were discussed. The second part of the training was dedicated to discussing the importance of the research assistants' role in the research process and their ethical responsibilities (e.g., confidentiality, data integrity) and potential consequences to the research team for misconduct and violations to research ethics in line with suggested recommendations (Lechago, 2009). At the end of the training, the research assistants were able to work with participants, parents and teachers in the field, demonstrated knowledge on how to obtain participant's informed

consent, mastered the standardised Chinyanja test instructions for each test in the battery, and were able to administer and score all the tests in the battery and pledged to carry out their ethical responsibilities.

***Translation research materials:*** All the administered measures and the intervention materials in the current study were first translated in *Chinyanja* from English and then translated back into English from *Chinyanja* by a professional language translator whose native language is *Chinyanja*.

***Pilot studies:*** A pilot study is a small-scale study conducted before the main study in order to determine the feasibility of the main study. The pilot study is the first step of the entire research process that serves to plan and modify procedures of the main study including the selection of study participants, preparation of the experimental conditions, testing of the instruments used for measurements in the study and training on how best to administer the instruments (In, 2017). In the current study, a pilot study was implemented after a training in order to fully equip the researchers and research assistants with knowledge and skills on the purpose, method, and procedures of the study from an experiential perspective. The goal of the pilot study was twofold. First, to collect preliminary data that would be used to test the adequacy and efficiency of the data collection instruments and their administration duration. Second to equip the researchers and research assistants with practical, hands-on skills of test administration. In a pilot study of 15 participants was conducted in Kalingalinga with similar demographics, drawn from the population of the main study. All except three executive function measures were found to be appropriate for further use in the main study.

The three problematic measures that reported floor effects included the trails making test, the Stroop test (dogs) and the digit span backwards, which has also been found to be a difficult task for preschool learners in prior studies (Bull et al., 2008; Davidse et

al., 2015). These tests were later excluded from the final test battery administration in the main study. In order to minimise fatigue, tests that used pictures were administered. These test battery adjustments were earmarked to improve the test battery administration time and attention span.

#### **4.9 Data Diagnostics**

In order to ensure that the data that was entered was reliable, the following statistical techniques were applied to deal with outliers, missing values and normal distribution. First, the data was winsorised. This technique of dealing with outliers has been recommended to be the most effective (Dixon, 1980, 1960; Anscombe and Tukey, 1963). Second, for variables of interest that were skewed, data transformations were applied. Finally, composite scores were generated using factor analysis.

#### **4.10 Statistical Analyses**

This section explains the specific statistical data analysis tools that were used to analyse the variables. Statistical analysis was performed in Statistical Package for Social Sciences (SPSS) version 23 and the open access statistical software called *Jamovi* version 1.6.2.3.0.

First, all the data was entered and cleaned (outliers and missing values), then it was checked to confirm whether the assumptions needed for inferential statistics were met or violated. Inferential statistics can only be conducted when the relevant statistical assumptions associated with the specific statistical tests are met.

We used Shapiro–Wilk test because it is a widely used and rigorous statistical test to test normality for data that is normally distributed and the sample size was large enough to provide reliable inferences. The data was also inspected visually by examining the

histograms, box plots (checked for potential outliers), P–P Plots and the Q–Q Plots that were generated by SPSS. For variables that were not normally distributed, transformation alternatives were conducted. Some transformations successfully normalised some variables. Factor analyses were also performed on some variables in order to reduce the number of variables. Using fewer variables helps to conserve degrees of freedom and improve statistical power against type II error (Finney, 2007).

**Reliability analyses.** After checking for the assumptions of normality, the next step taken was to determine the internal consistency of the test items to ascertain the reliability of the instrument. In order to do this, the current study checked for reliability using the SPSS generated Cronbach alpha or coefficient alpha.

**Correlational analyses.** To examine correlations between the target variables, Pearson bivariate correlations were calculated. In addition, this study analysed the correlations of predictor variables to outcome variables for all separate executive function measures. Comparisons between groups, such as the intervention versus control group children were computed to check how these variables correlated with each other.

**Regression analyses.** Finally, regression analysis (hierarchical multiple regression, moderated multiple regression) was used as a tool to predict outcome variables (phonological awareness, vocabulary) based on predictor variables (executive functions, intervention). These analyses allowed the researcher to determine the percentage of the variation in the outcome variable that was explained by the combination of predictor variables in the model.

**Moderation analyses.** Moderation analysis allowed the researcher to test for the influence of executive function, on the relationship between the intervention and phonological awareness. Rather than testing a causal link between these variables,

moderation tested for when or under what conditions an effect occurred. Moderators can strengthen, weaken, or reverse the nature of a relationship. For example, executive functions moderated the relationship between the intervention and phonological awareness. Specifically, participants with low executive functions were reported to have better phonological awareness and vocabulary and vocabulary skills than students with high executive functions. Executive functions were considered a moderator in this case. In general, moderation can be tested by interacting variables of interest (moderator with IV) and plotting the simple slopes of the interaction, if present.

#### **4.11 Ethical Approval Guidelines**

This study was carried out in accordance with the standards and procedures for ethical treatment of human subjects in line with the ethical standards of declaration of Helsinki (“World Medical Association Declaration of Helsinki,” 2013) and was approved by the University of Zambia Humanities and Social Sciences Research Ethics Review committee. Permission to conduct the study was obtained from the appropriate offices as earlier explained. Parents signed consent forms and completed a questionnaire including their demographic details and other information related to their interaction with the sampled child.

#### **4.12 Philosophical Underpinnings of the Study**

Having described the specific components of the research approach (quantitative approach) of the current study, there is need to briefly explain how the researcher arrived at the quantitative research approach. The research paradigm influences the decision on a research approach (Creswell, 2009; Eyisi, 2016). In the present study, the aim was to obtain objectivity in understanding reality through statistical means. This

approach is consistent with positivism. This research philosophy conforms to the use of quantitative methods and methodologies that are used to collect, analyse and interpret the data. The following five research features show how the present study's adoption of the positivist paradigm dictated the research process right from the hypotheses to the report writing stage. First, the four study hypotheses of this study informed by positivist assumptions could only be tested using research methods such as the use of the experiment whereby scenarios where various conditions (such as a control vs. intervention) were used and the impact of the independent (rhymes and stories) variable on a dependent variable (phonological awareness) were examined. In this experiment, a between-subjects design was used where each participant was exposed to just one condition, and group differences between individuals in different conditions (action video games, intervention and free play) were compared.

The second feature that was influenced by the positivist paradigm was the sample size. Here, the basic principle is that the number of participants should be larger than 100 for better statistical outcomes. The present study investigated a representative sample of 375 pre-schoolers drawn from 14 schools across three districts. This sample was large enough to yield reliable and valid results. Third, data collection was influenced by the principle of standardisation. This was achieved by making all the tests have uniform administration procedures such as instructions and settings. This entailed giving the tests of executive functions and rhyme awareness to all participants uniformly and grading their performance in a standard manner. The intervention and control conditions were standardised in terms of the duration of exposure to the specific conditions. For instance, the duration of exposure to all the conditions was 12 minutes.

Fourth, the statistical tool used for managing, processing and analysing the data that was collected is the Statistical Package for Social Sciences (SPSS). The use of

statistics in this study confirms the adoption of the positivist paradigm that later determines that reality is object just like statistics. The use of statistics to analyse data was motivated by the need to present it in more understandable ways. This allows researchers to gain a better understanding of the data and seek for trends by using visual displays including graphs, pie charts, frequency distributions, simple slopes and scatterplots. These are objective methods of presenting data (Keren, 2014).

Finally, in quantitative research, generalisation, which is the act of reasoning that entails deriving general conclusions from specific observations, is universally regarded as a quality criterion. The guiding rule here is that results can only be generalised if the sample was representative and large enough compared to the target population. This principle is also derived from the positivist paradigm. The extent to which these study findings are generalised to the general population depends on the nature of both the participants and the quality of the preschools being investigated.

Having explained how the research approach was influenced by the research paradigm, the next section explains the components of the current research paradigm. While ontology focusses on the reality out there (what exists), epistemology refers to how one can know about the reality, methodology refers to the procedures we can use to acquire knowledge about reality and the methods are the tools to use to acquire this knowledge (Imenda, 2014). Ontologically speaking, the nature of preschool aged children in public schools with executive function strengths and deficits and the intervention provided and phonological awareness was the focus of this investigation. The intervention was provided so that the role of executive functions in the interventions effect on rhyme awareness could be investigated. The epistemological perspective of the study consisted of the rationale for the study, theoretical framework that guided the study and the scholars cited in this study. The above outlined

benchmarks were proposed by Evans (2007). The following section now examines how the philosophical assumptions were addressed in the current study.

In terms of the epistemological assumption, the researcher did not influence the research outcomes because there was distance between the researcher and participants. The use of research assistants was evident in data collection. The ontology assumption was tested by looking at reality from the quantitative perspective. This was done by attempting to describe reality using numerical data and breaking down the observations according to the variables that were identified such as executive functions, rhymes, stories and rhyme awareness. From the axiological assumption viewpoint, efforts were made to avoid any sort of biasness at every stage of the research process by the use of blinding when assigning participants to the various conditions.

In conclusion, the research paradigm is clearly coming out of the above stated assumptions and how they were addressed in the present study. Based on these assumptions, positivism is the research paradigm that informed this study although the philosophy of science at the moment is moving somewhat away from positivism to a wider understanding of science and knowledge (Aliyu et al., 2015). This could mean that positivism, as research paradigm no longer sufficiently explains experimental designs. This is because experimental science has evolved with time.

#### **4.13 Summary**

This chapter discussed the methodological aspects of the study namely the epistemology of the study, research design, participants, data collection procedure, assessment instruments and the ethical guidelines. The chapter described the methods that were used to collect the data in order to test the hypotheses. The methodology that was used in the current study served three purposes. First, it was well suited to address

the research problem and the associated research gaps uncovered in the introduction chapter. Second, information about the assessment instruments explained in this chapter helped to provide clarity on the operational definitions of key constructs. Finally, there is no doubt that the results obtained from the current study provide reliable evidence of the contribution of executive function in predicting the effect of digital rhymes and stories on phonological awareness and could be generalised based on the main methods used. The study was not only objective but also informative because it used all the three main types of analyses, descriptive, correlational and regression analyses. Ethical standards for dealing with participants were followed especially that participants were drawn from diverse geographic areas such as Kafue, Chilanga and Lusaka.

## **CHAPTER FIVE**

### **PRESENTATION OF RESULTS**

#### **5.0 Overview**

This chapter reports the findings of the statistical analyses that were used to test the hypotheses of this study. Descriptive information about the participants is provided, then the statistical findings for each hypothesis are presented. The five research hypotheses include the following. First, executive function performance increased from pre-intervention to Grade One. Second, executive functions predicted phonological awareness. Third, executive functions moderated the effect of the intervention on phonological awareness. Fourth, task orientation as a component of executive functions explained variance over and above other executive function measures. Finally, there were sex differences in executive function task performance.

#### **5.1 Participants**

Out of the 375 participants who were included in the study, 22 (5.8 %) failed to complete the assessments and treatment due to absenteeism arising from sickness and school transfer. This resulted in a total of 353 participants included in the final analysis. Figure 7 describes the flow of participants at every stage of the study and the number of participants included for the final analyses.

#### **5.2 Descriptive Statistics**

A total of 375 preschool participants were recruited from 14 public schools in Lusaka Province. The participants' age was 81.09 months, 48% of the participants were males, and 73% spoke Chinyanja. On a scale ranging from 0 to 11, the average score on home possessions was 7.95 ( $SD= 2.02$ ). Regarding the caregiver's level of education, on a scale of 0 (never been to school) to 5 (bachelor's degree completion), the education

level of the caregiver was 1.97 ( $SD= 1.08$ ). This indicated that the average level of education for caregivers was junior secondary education.

**Table 3: Descriptive statistics of Participants**

<b>Variable</b>	<b>Descriptive</b>	<b>Animations</b>	<b>Games</b>	<b>Control</b>	<b>Total %</b>
<b>Age</b>	Mean	80.16	82.20	80.92	
	SD	15.30	16.10	15.78	
	Minimum	52	46	54	
	Maximum	119	115	115	
<b>Gender</b>	Males	15.60	16.10	16.10	48%
	Females	19	17	16.10	52%
<b>Language</b>	Chinyanja	25.80	24.40	23.30	73%
	Other languages	4	4.20	5.40	27%
<b>HPI*</b>	Mean	7.95	8	7.92	
	SD	2.08	2.03	1.95	
	Minimum	2	2	2	
	Maximum	11	11	11	
<b>Caregiver Occupation</b>	No employment	13.5	9.90	9.30	33%
	Non-formal	13.5	14.4	13.1	41%
	Formal	8.30	9	9	26%
<b>Caregiver Education level</b>	No education	1.60	2.20	1.30	5.10
	Primary	12	11.1	11.1	34
	Junior Sec.	11.70	8.50	8.20	29
	Senior Sec.	8.20	7.90	7.90	24
	Post-Secondary	0.90	3.80	2.50	7.30
	Bachelor's degree	0.60	0	0.30	0.90

*Note.* \* Home Possession Index including possessions like flushing toilet, home stove, television, etc. Caregiver's level of education was scored on a scale of 0 (never been to school) to 5 (bachelor's degree completion)

A Pearson's product-moment correlation was run to assess the relationship between Phonological Awareness (PA), the outcome variables and the executive functions (EF), which was the predictor variable in pre-schoolers. The researcher checked whether the relationships were linear, all the variables were normally distributed, as tested by Shapiro-Wilk's test ( $p > .05$ ), and there were no outliers. There was a statistically significant moderately strong positive association (.31) between PA and task orientation (See Table 4) and a statistically significant but small positive correlation between PA and the other three EF measures: Stroop ( $r=.16$ ), Digit span ( $r=. 21$ ) and Pencil tap ( $r=. 27$ ).

This suggests that better executive function scores are moderately related to better phonological awareness. The interpretation of the magnitude of these correlation coefficients is in line with Cohen's guidelines. The magnitude of correlation coefficients are considered small, moderate and large when they are “.10”, “.30” and “.50” respectively in accordance to Cohen (Hemphill, 2003).

**Table 4: Correlations for Phonological Awareness and Executive Functions**

	1	2	3	4	5
1. PA	—				
2. Stroop	0.159 **	—			
3. Digit Span	0.205 ***	0.061	—		
4. Pencil Tap	0.279 ***	0.227 ***	0.234 ***	—	
5. Task Orientation	0.306 ***	0.190 ***	0.211 ***	0.250 ***	—

*Note.* PA= Phonological Awareness; \*\*  $p < .01$ , \*\*\*  $p < .001$

While task orientation was used to measure sustained-attention of the participants, the Stroop test assessed inhibitory control, digit forward span to assess short-term memory, and the pencil tap to measure working memory. Phonological awareness in this study

was operationalised as a composite score of three rhyming measures namely picture rhyming, rhyme recognition and rhyme production, executive function was conceptualised as performance on the Stroop test in the moderated hierarchical linear regression model and task orientation in the multiple regression.

### **5.3 Hypothesis Number 1: Pre-schoolers' Performance on Executive Functions (EF) Tests from Preschool to Grade One**

In order to determine whether there was a statistically significant difference in the performance of participants on executive functions (EF) tests over the course of time, from pre-intervention to Grade One, a one-way repeated measures ANOVA was conducted. There were no outliers on EF measures and the data was normally distributed at each time point, as assessed by visual inspection of the boxplot and Shapiro-Wilk test ( $p > .05$ ), respectively. The assumption of sphericity was met for all the EF measures, as assessed by Mauchly's test of sphericity (see Table 5). Three time points in the current study were used to assess executive functions because pre-schoolers' executive functions are still maturing, so it may be difficult to use a single assessment to predict how these abilities developed (Anderson, 2002).

Task orientation scores increased first then stabilised (see Figure 8) from pre-intervention ( $M = 28.07, SD = 8.34$ ) to post-intervention ( $M = 31.35, SD = 6.75$ ) to Grade One ( $M = 29.85, SD = 8.09$ ). Digit span scores increased (see Figure 9) from pre-intervention ( $M = 6.00, SD = 1.94$ ) to post-intervention ( $M = 6.63, SD = 1.94$ ) to Grade One ( $M = 6.88, SD = 1.90$ ) and Pencil Tap test scores also increased (see Figure 10) from pre-intervention ( $M = 25.13, SD = 9.60$ ) to post-intervention ( $M = 28.66, SD = 9.25$ ) to Grade One ( $M = 32.24, SD = 7.26$ ). Stroop was not included in this analysis because of the test's ceiling effect in Grade One.

**Table 5: One-way Repeated Measures ANOVA for the EF Measures**

EF measure	Mauchly's test ( <i>p</i> )	df, Error (Time)	<i>F</i> -Value	<i>P</i>	Partial $\eta^2$
Task Orientation	.195	2,386	10.79	< .003	.05
Digit Span	.656	2,460	22.35	< .004	.09
Pencil Tap	.028	2,460	73.86	< .001	.24

Note. *p* < .001, df, Error (time) = degrees of freedom for time and for error (time)

Table 5 shows that the assumption of sphericity was met for all the EF measures used in this analysis. This was assessed by Mauchly's test of sphericity. This assumption has to be met before the one-way repeated measures ANOVA could be conducted. This is a statistical tool that is used to compare three or more group means where the participants are the same in each group.

**Table 6: Descriptive Statistics of EF Measures**

EF Measures		<i>M</i>	<i>SD</i>
Task Orientation	Pretest	28.07**	8.34
	Posttest	31.35**	6.75
	Grade one	29.85**	8.09
Digit Span	Pre- test	6.00**	1.94
	Post-test	6.63**	1.94
	Grade one	6.88	1.90
Pencil Tap	Pretest	25.13**	9.60
	Post-test	28.66**	9.15
	Grade One	32.24**	7.26

Note. \*\* *p* < .05

## POST HOC ANALYSES

### Task Orientation

Post hoc comparisons using the Least Significance Difference (LSD) test indicated that the mean score for the pre-intervention (*M* = 28.07, *SD* = 8.34) was significantly different from the post-intervention (*M* = 31.35, *SD* = 6.75) well as that of the pre-

intervention and grade one. The significant mean difference in scores was also observed for post-intervention and grade one as shown in Table 6.

### **Digit span**

Post hoc comparisons using the Least Significant Difference (LSD) test indicated that the mean score for the pre-intervention ( $M = 6.00$ ,  $SD = 1.94$ ) was significantly different from the post-intervention ( $M = 6.63$ ,  $SD = 1.94$ ) well as that of the pre-intervention and grade one. However, the performance at post-intervention did not statistically differ from that of grade one ( $M = 6.88$ ,  $SD = 1.90$ ) as shown in Table 6.

### **Pencil Tap**

Post hoc comparisons using the Least Significant Difference (LSD) test indicated that the mean scores for the three time points: pre-intervention ( $M = 25.13$ ,  $SD = 9.60$ ), post-intervention ( $M = 28.66$ ,  $SD = 9.25$ ) and that of grade one ( $M = 32.24$ ,  $SD = 7.26$ ) were significantly different from each other as shown in Table 6.

**Figure 8: Task Orientation Performance at Three Time Points**

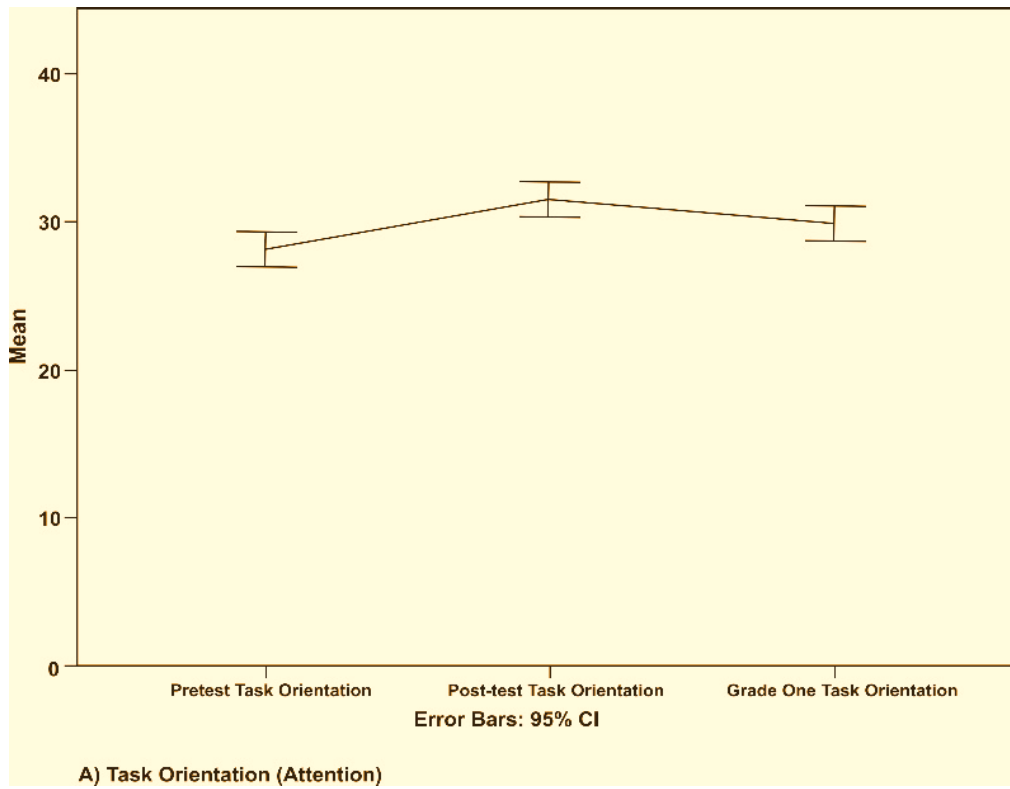
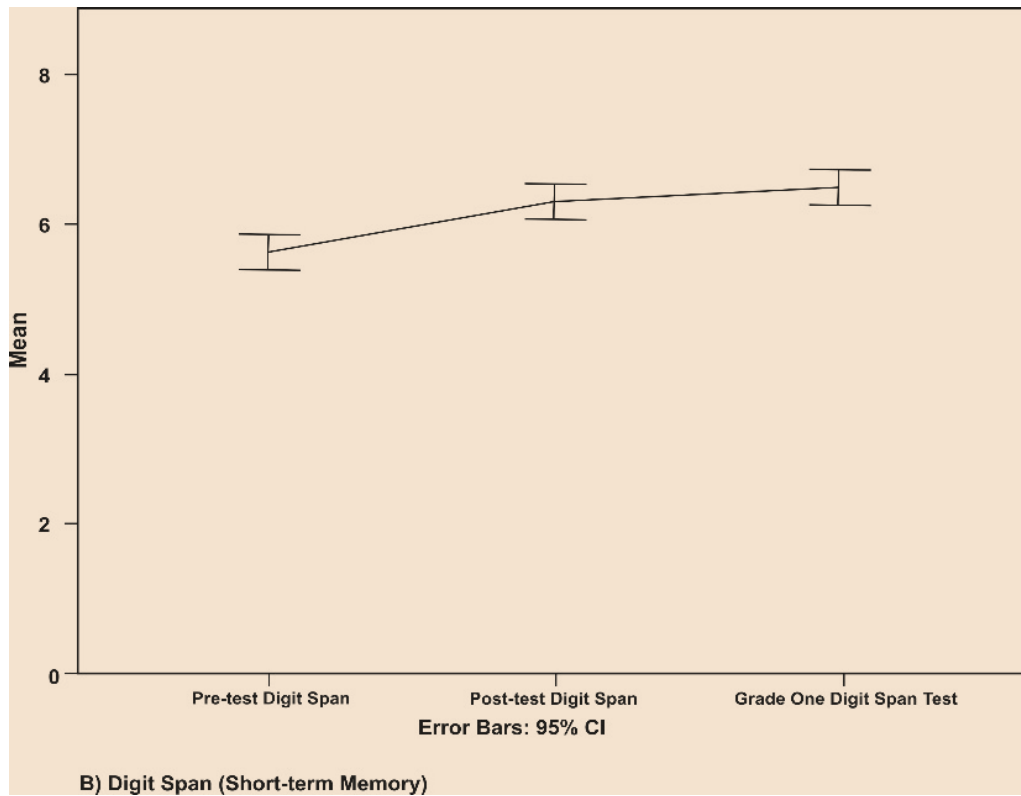


Figure 8 shows that there was a considerable increase in attention between time one (pretest) and time two (post-test), ability to sustain attention levelled off between time two and time three (grade one).

**Figure 9: Digit Span (Short-Term Memory) Performance at Three Time Points**



The ability to retain limited amounts of material for a limited time period improved as participants transitioned from preschool to grade one as shown in Figure 9.

**Figure 10: Pencil Tap (Working Memory) Performance at Three Time Points**

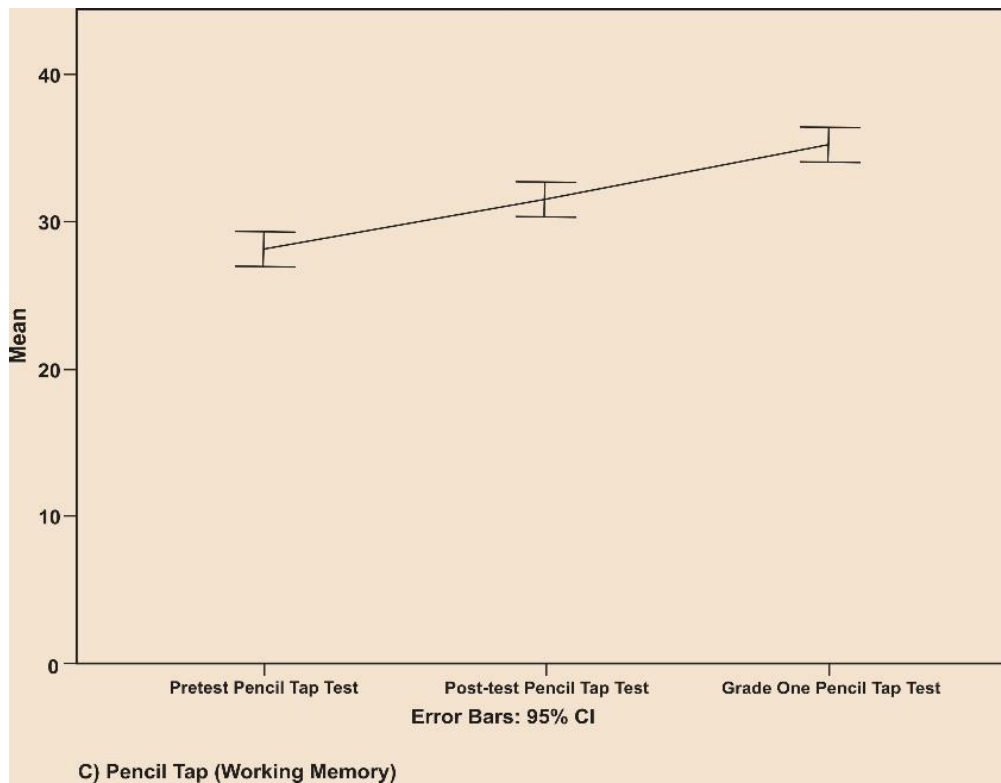


Figure 10 illustrates the performance of participants on the working memory test from preschool to grade one. Overall, the ability to hold information in the mind for a brief period of time while doing something else also increased from preschool to grade one.

#### 5.4 Hypothesis Number 2: Executive Functions Predict Phonological Awareness

Phonological awareness was regressed on executive functions (measured by RAN, digit span, Stroop, pencil tap and task orientation) to determine whether EF predicts phonological awareness. The multiple regression model as shown in Table 7 statistically significantly predicted phonological awareness,  $F(5, 284) = 10.957, p < .001$ ,  $\text{adj. } R^2 = .16$ . All the EF measures (digit span, Stroop, pencil tap and task orientation) except RAN ( $\beta = .02$ ) added significantly to the prediction,  $p < .05$ . Table 7 shows the regression coefficients and standard errors that suggest that executive functions could influence phonological awareness to some extent.

**Table 7: Multiple Regression Results for Phonological Awareness**

Phonological Awareness	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	$\beta$	$R^2$	$\Delta R^2$
		<i>LL</i>	<i>UL</i>				
Model						.16	.15
Constant	-	-2.61	-	.35			
	-		1.22				
	1.92***						
Stroop	.02*	.00	.03	.01	.13*		
Digit span	.08*	.02	.13	.03	.15*		
Pencil tap	.01*	.00	.03	.01	.14*		
TO	.02***	.01	.04	.01	.21***		

\* $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

*Note.* Model = “Enter” method in SPSS Statistics; *B* = Unstandardised regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient;  $\beta$  = standardized coefficient;  $R^2$  = coefficient of determination;  $\Delta R^2$  = adjusted  $R^2$ ; TO= Task orientation.

### 5.5 Hypothesis Number 3: Directly Assessed Executive Functions Account for a Large Amount of Variance in Phonological Awareness Over and Above Reported Executive Functions

A hierarchical multiple regression was run to determine the executive function measures (direct vs indirect measures) that account for a larger variance in phonological awareness: pencil tap, digit span, and Stroop (direct EF measures), and task orientation (Indirect measure). See Table 8 for full details on each regression model. The model of Stroop, digit span, and pencil tap to predict phonological awareness (Model 1) was statistically significant,  $R^2 = .122$ ,  $F(4, 290) = 13.430$ ,  $p < .001$ ; adjusted  $R^2 = .113$ . The addition of Task Orientation (TO) to the prediction of phonological awareness (Model 2) also led to a statistically significant increase in the coefficient of determination from .113 to .164,  $F(4, 290) = 14.195$ ,  $p < .001$ .

While direct executive function measures were tests that were administered to the participants and the performance was scored, reported executive function measures were reported observations on the participant's behaviour during assessment.

**Table 8: Hierarchical Linear Regression Coefficients of EF Measures Predicting Phonological Awareness (N=290)**

Phonological Awareness	B	95% CI for B		SE B	$\beta$	$R^2$	$\Delta R^2$
		LL	UL				
Model						.16	.15
Constant	-1.85** *	-2.37	-	.26			
Stroop	.02*	.00	.03	.01	.12*		
Digit span	.07*	.02	.13	.03	.14*		
Pencil tap	.01*	.00	.03	.01	.14*		
TO	.03***	.01	.04	.01	.22***		

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Note. Model = "Enter" method in SPSS Statistics; B = Unstandardised regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit; SE B = standard error of the coefficient;  $\beta$  = standardised coefficient;  $R^2$  = coefficient of determination;  $\Delta R^2$  = adjusted  $R^2$ ; TO= task orientation.

**5.6 Hypothesis Number 4: Executive Functions (EF) Moderates the Relationship between the Intervention (Digital Stories and Rhymes) and Phonological Awareness (PA)**

To test whether executive functions moderated the effect of the intervention (digital stories and rhymes, RS) on phonological awareness (PA), we ran a hierarchical linear regression with post-test phonological awareness as outcome variable and pre-test phonological awareness, EF, intervention, and interaction terms as predictors. We entered EF, intervention and pre-test phonological awareness at step 1 and at step 2, and we entered the two-way interaction terms [created by multiplying the standardised values of the intervention and EF]. Table 9 shows that EF ( $p < .002$ ) and intervention by EF ( $p = .041$ ) yielded significant effects.

This positive interaction indicated that in the presence of EF, the relationship between the intervention (RS) and phonological awareness (PA) was strengthened.

**Table 9: Moderation Estimates of EF on the Relationship between Intervention and Phonological Awareness**

Relationship	Estimate	SE	95% Confidence Interval		Z	p
			Lower	Upper		
<b>Intervention</b>	0.98900	0.03797	0.08430	0.0645	0.260	0.795
<b>EF</b>	0.21580	0.00709	0.00768	0.0355	3.044	0.002***
<b>Intervention*EF</b>	0.09920	0.00485	0.01942	4.13e-4	2.045	0.041*
<b>Intercept</b>	0.36994	0.04461	0.02003	0.24418	1.568	0.117

Note. \* EF= Executive Functions, \* $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

As shown by Table 10 below, executive functions were significant,  $F [2, 316] = 4.10, p = .018, R^2 = .025$ . There was a significant main effect of executive function ( $\beta = .17, p = .003$ ) and a significant two-way interaction effect ( $\beta = -.35, p = .044$ ) between intervention and executive function,  $F [3, 315] = 3.16, p = .026, R^2C = .038$ .

Therefore, these results seem to suggest that the rhymes and stories on their own could not influence better phonological awareness outcomes. The introduction of executive functions in the model seems to have improved the effect of the intervention on rhyme awareness. This suggests that executive functions such as sustained attention tend to affect the way children respond to emergent literacy interventions.

**Table 10: Hierarchical Multiple Regression Predicting Phonological Awareness from EF and the Interaction Term (EF and Intervention)**

Phonological Awareness	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	$\beta$	<i>R</i> <sup>2</sup>	<i>R</i> <sup>2</sup> C
		<i>LL</i>	<i>UL</i>				
Model						.025	.038
Constant	-.53*	-2.61	-	.18			
			1.22				
EF	.02*	.00	.03	.01	.17*		
EF by intervention	-.01*	-.01	-.00	.01	-.35*		

\**p* < .05, \*\* *p* < .01, \*\*\* *p* < .001

Note. Model = “Enter” method in SPSS Statistics; *B* = Unstandardised regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient;  $\beta$  = standardised coefficient; *R*<sup>2</sup> = coefficient of determination; *R*<sup>2</sup> C = Square Change.

**Figure 11: Simple Slope Interaction Analysis of the Executive Functions (EF) and Intervention (RS) on Phonological Awareness (PA)**

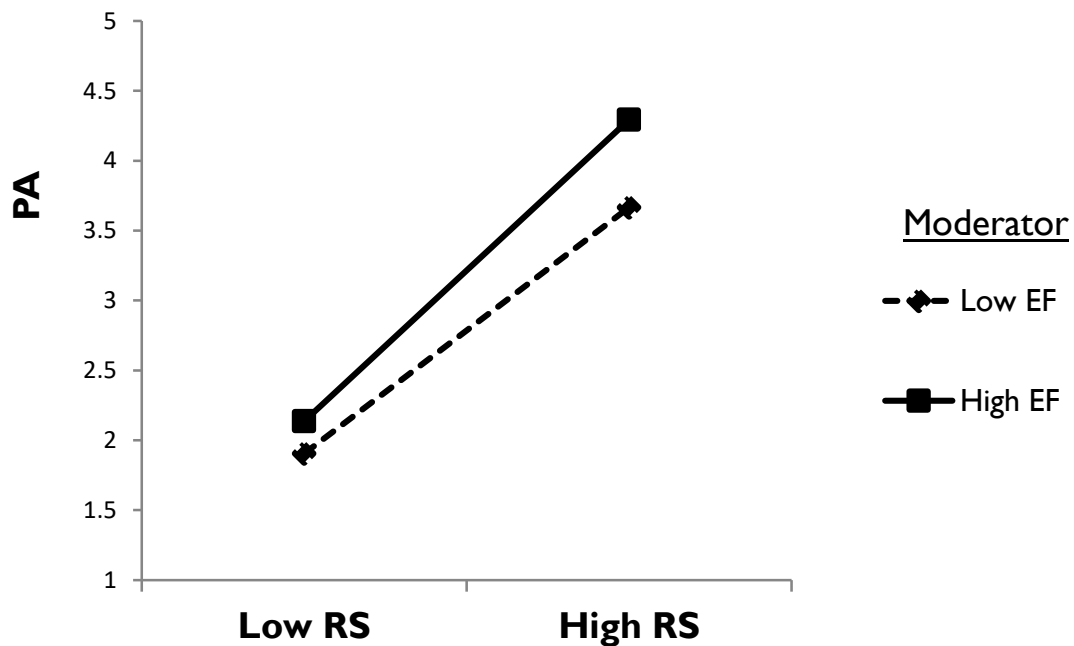


Figure 9 shows the results of a simple slope analysis conducted to better understand the nature of the moderating effects of executive functions. As can be seen in Figure 9, the solid line representing high executive functions (EF) is much steeper compared to the broken line representing low executive functions (EF). This suggests that at high level of EF, the impact of the intervention (RS) on phonological awareness (PA) was much stronger compared to low level of EF. As EF increased, the strength of the relationship between the intervention and phonological awareness also increased. In other words, EF strengthens the positive relationship between RS and PA.

### **5.7 Summary**

This chapter aimed at identifying the research hypotheses and how these were tested in order to address the aim of the study. Based on statistical analyses of five research hypotheses, it can be concluded that executive function performance increased from pre-intervention to Grade One. Executive functions also predicted and moderated the effect of the intervention on phonological awareness. Finally, task orientation explained a large amount of variance over and above other executive function measures.

## CHAPTER SIX

### DISCUSSION OF FINDINGS

#### 6.0 Overview

This chapter attempts to respond to the following key questions in an effort to comprehensively interpret the current findings: What were the main findings? What are the potential explanations for the current results? How do the results compare to the stated hypotheses? How can the current results be compared to what others have found on this topic? What were the limitations and solutions to the limitations of the current study? And finally, what are the questions for future research? In addressing these key questions, the meaning and relevance of the results are discussed. This will be done by discussing each of the hypotheses stated in Chapter One. For the purpose of emphasis, the four objectives of the study will be re-stated to remind the reader of the aim of this study.

While executive functions are important determinants of reading and writing in primary school, not much is known about their role in moderating the effect of emergent literacy interventions on phonological awareness in the Zambian preschool context. This is exacerbated by the research bias towards investigating phonological awareness in English rather than bantu languages (Daries et al., 2022; Diemer et al., 2015; Lukama, 2016; Schaefer & Kotzé, 2019; Trudell & Schroeder, 2007; Wilsenach, 2013, 2019). This study examined the moderation role of executive functions in the relationship between the rhyme, stories intervention and emergence of rhyme awareness.

This study suggests that inhibitory control as a component of executive functions (EF) was able to moderate the relationship between the targeted intervention (rhymes and stories) and phonological awareness particularly rhyme awareness in

preschool-aged children in Zambia. This implies that at high levels of executive functions, the effect of the intervention on rhyme awareness was much stronger than at low executive functions. As EF increased, the strength of the relationship between the intervention and rhyme awareness also increased. This suggests that children with high executive functions tended to benefit more from the intervention than children who had low executive functions.

The aim of the study was achieved by addressing the following four research questions. First, what was the performance of the participants on EF tasks from preschool to Grade One? Second, did executive functions (EF) predict rhyme awareness? Third, which of the executive function assessment approaches better predicted phonological awareness (rhyme awareness)? Finally, did executive functions moderate the relationship between the rhyme and stories intervention and phonological awareness (rhyme awareness)?

### **6.1 Summary of the Findings According to the Hypotheses**

For the first research question, EF performance of participants from preschool to Grade One significantly improved over time, the performance in Grade One was statistically significant compared that of preschool learners. As for the second research question, the present study found that as expected, executive functions, strongly predicted rhyme awareness. Regarding the third question, the study found that indirect EF measures, particularly the task orientation was a better predictor of rhyme awareness than direct measures of executive functions such as the Stroop, digit span or the pencil tapping test. Finally, regarding the fourth question that examined the role of executive functions in moderating the relationship between the intervention and rhyme awareness, the study found that executive functions, precisely inhibitory control, moderated the relationship

between the intervention (rhymes and stories) and rhyme awareness. The relationship between the intervention and rhyme awareness changed as a function of executive functions. Participants who had greater inhibitory control abilities tended to easily identify rhymes than their counterparts who had limited inhibitory control.

The findings provide support for the notion that improving young children's emergent literacy outcomes such as phonological awareness, requires paying attention also to the development of their executive skills and taking away risk factors that may hinder executive functions (EF) as early as possible (Cameron et al., 2012; Davidse et al., 2015; Nesbitt et al., 2015; Segers et al., 2016; van de Sande et al., 2013). The findings also indicated that enhancing executive functions in preschool children may also indirectly affect the development of phonological awareness such as rhyme awareness. This study has not only provided evidence for the value of EF in predicting later early literacy skills, but is also suggesting for the need to have routine EF assessment as a strategy for early identification of learning problems upon entry into Grade One.

The preceding sections have briefly explained the four study objectives and the findings based on each objective. The following sections will provide plausible explanations for the current findings. These explanations will be organised in accordance with the research hypotheses stated earlier. The first section will provide plausible explanations for the development of executive functions from preschool to Grade One. Secondly, the section will explain the reasons for the predictive role of executive functions on rhyme awareness in preschool learners. Thirdly, the discussion will move towards providing potential explanations for the superiority of indirect measures over direct measures of preschool executive functions. Lastly, the plausible

explanations for the moderation role of executive functions in the relationship between intervention and rhyme awareness will be discussed.

## **6.2 Hypothesis Number 1: Grade One Learners Performed Better on Executive Function (EF) Tasks than Preschool Learners**

The current study hypothesized that executive functions, especially working memory and inhibitory control of the participants would be improved when they progress to Grade One. The performance on four EF tasks was examined from preschool to Grade One. The study found that performance on the executive function tasks improved significantly from preschool to Grade One. These findings are in agreement with past studies that demonstrate age differences in executive functions during preschool years (Dias et al., 2013; Gandotra et al., 2021; Juric et al., 2013; Kray et al., 2004; Ólafsdóttir et al., 2020; Pureza et al., 2013).

These findings are attributed to the following two explanations. First, the tasks that were used to measure EF skills reliably captured individual differences and gains in the two EF domains that were assessed: working memory and inhibitory control. Some EF tasks required children to inhibit the natural response and stick to rules, such as tapping a pencil once when an examiner tapped twice and tapping a pencil twice when an examiner tapped once. Such a task required the child to master the three rules and block an irrelevant response while responding correctly to a relevant one. Secondly, the improvement in EF performance from preschool to Grade One could be due to learning- or experience-driven processes that influence brain process during the course of the intervention. As observed by different cognitive theorists, the ability to exhibit desirable learning outcomes improve with increased age (Schiff & Vakil, 2015). Executive functions have been shown to undergo significant developments throughout their lifespan (Davidse et al., 2015; Diamond & Taylor, 1996; Kaushanskaya et al.,

2017; Rennie et al., 2004). For instance, inhibitory control starts with motor abilities, next perceptual skills follow and then linguistic domains emerge (Dempster, 1993). Others have argued that although EF develops rapidly during the preschool years (Gooch et al., 2016; Moriguchi et al., 2016; Müller & Kerns, 2015), they delay to grow when compared to all cognitive abilities because they are regulated by the prefrontal cortex, a brain region that is latest to develop in human beings (Mazuka et al., 2009) but continues to mature beyond adolescence. While executive functions improve with age, they also decrease with age (Ferguson et al., 2021; Lloyd et al., 2021; Vaccarino et al., 2021). The recent argument that executive functions are influenced by age is quite limited because of the non-availability of empirical evidence to show the exact time when age begins to improve or decline (Tonér & Gerholm, 2021).

### **6.3 Hypothesis Number 2: The Predictive Role of Executive Functions in Rhyme Awareness**

The second hypothesis of the present study was that executive functions would predict improved performance on rhyme awareness tasks. As expected, the study found that executive functions predicted improved performance on phonological awareness tasks consistent with prior studies (Beisly et al., 2020, 2022; Cameron et al., 2012; Kegel & Bus, 2014; Lonigan et al., 2016; Nayfeld et al., 2013; Sasser et al., 2015; Son et al., 2019; Welsh et al., 2010; Willoughby et al., 2012). The current findings are somewhat different from the findings by Miller and colleagues (2012) who studied working memory, inhibitory control, and school readiness in a sample of 129 pre-schoolers aged three to five and found that inhibitory control did not uniquely contribute to letter recognition.

There are varied explanations for the link between executive function and emergent rhyme awareness. According to one perspective offered by Yang and others

(2014), interference suppression, which is a component of executive functions plays a crucial role in activities that assess early orthographic knowledge and phonological awareness, particularly when these abilities have not yet been programmed. For example, a pre-schooler must filter any potential distraction from letters with similar shapes when recalling the shape of a letter of interest. Similar control can also exist at the phonological level, when it is important for the pre-schooler to focus exclusively on the sound of the word and ignore other distracting elements like its meaning. In other words, interference suppression would help pre-schoolers to choose the correct bit of information when faced with competing stimuli, especially when learning new abilities.

The second explanation for these findings provided by Gandolfi and others (2021) suggests that pre-schoolers who perform better at interference suppression (an aspect of executive functions within the inhibitory control component) are more willing to learn and profit more from classroom learning programmes. A pre-schooler with better interference suppression, for example, might be better at listening to the teacher's guidance and remain focused by blocking out distracting and irrelevant information. Furthermore, it is recommended that executive function processes are associated with pre-schoolers' higher cognitive competence, and that specific interference suppression could assist higher cognitive monitoring by attempting to prevent children from becoming side-tracked by external cues even as they refresh their representations. This idea suggests that inhibitory control processes, metacognitive processes, and accomplishment all work together in a coordinated fashion. The proposition that there is a connection between interference suppression, an aspect of executive functions and emergent literacy is consistent with the argument suggested by Blair and Raver, (2015), on the importance of self-regulation in preparing pre-schoolers for success in school.

The final plausible explanation for this study's findings could be that for phonological awareness to occur, children need to focus their attention on structural features of the spoken words. Staying focused on the sounds enables the children to be aware of the rhymes. Cognitive skills such as attentional control, working memory and inhibition responsible for phonological awareness acquisition have been found to facilitate development of phonological skills (Alloway et al., 2004; Leather & Henry, 1994; Oakhill & Kyle, 2000; Peng et al., 2013; Rohl & Pratt, 1995; Scheepers et al., 2021). Successful performance on a rhyme awareness task requires one to actively manipulate information and properly keep in mind calling for the use of working memory. Failure to hold information in memory leads to poor performance of linguistic tasks such as rhyming (Schaefer & Kotzé, 2019). The relationship between executive functions and rhyme awareness is explained by the functional interconnection that exists between the dorsolateral prefrontal cortex and the left temporal lobe which is responsible for language function (Anderson & Tranel, 2002).

The findings in the present study are supported by prior research, showing that early academic skills and executive function mechanisms are strongly correlated (Alloway et al., 2005; Franceschini et al., 2012; Gooch et al., 2016; Kegel & Bus, 2014; Kwakkel et al., 2021; McClelland et al., 2007; van de Sande et al., 2013; Weiland et al., 2014; Yang et al., 2014). More recently, Kwakkel and others (2021) showed that among bilingual Dutch/ English 5-year-old kindergarten in the Netherlands, visual sustained attention predicted L2 phonological awareness.

Using a hierarchical analysis, Yang et al (2014) found that a bidirectional relationship existed between phonological awareness and executive attention with the former predicting the later and vice versa. In support of the current findings, Van de Sande et al (2013) found that self-control facilitates the development of word decoding

via phonological awareness. In clinical populations, even after controlling for initial language ability and preschool performance, teacher-reported attention problems in preschool significantly and negatively predicted phonological awareness skills including phonemic awareness and letter naming scores, one year later. Dally (2006) further argues that executive functions such as attention facilitate phonological awareness by showing that inattentiveness hampered the development of phonological analysis skills in preschool children. This was consistent with the findings in this study.

In support of the current study findings, McClland et al (2007) also demonstrated that behavioural regulation, a measure of executive functions significantly and positively predicted phonological awareness. After controlling for the study site, child gender, and other background characteristics, improvement in behavioural regulation predicted growth in emergent reading, across the prekindergarten year. The present findings extend prior recent research conducted by Kwakkel and others (2021) that executive functions strongly predicted phonological awareness. Further, this relationship was stronger for monolingual and not for bilingual Dutch children. This relationship was noted for specific executive functions namely, verbal short-term memory and behavioural self-regulation. The present study examined inhibitory control and working memory. While prior studies (Kwakkel et al., 2021; Yang et al., 2014) have interrogated phonemic awareness and syllable awareness, this study examined yet another component of phonological awareness – rhyme awareness, which appears to have no due investment yet in the Zambian preschool context.

#### **6.4 Hypothesis Number 3: Indirect Executive Function Measures Predict Phonological Awareness**

It was hypothesized that direct executive functions (EF) measures would strongly predict phonological awareness skills compared to indirect measures. Contrary to what

was expected, this study found that the indirect EF measures rather than direct EF measures strongly predicted phonological awareness skills. While these findings are different from previous research that found that direct EF measures predict emergent literacy outcomes in preschool learners (Allan & Lonigan, 2011; McClelland et al., 2007; Miller et al., 2012; Ponitz et al., 2009; Willoughby et al., 2012), some prior studies (Allan et al., 2014a; Blair & Razza, 2007; Hooper et al., 2020; Lonigan et al., 2017; Ribner et al., 2017; Toplak et al., 2013) are consistent with the current findings but these studies remain non-generalisable to the Zambian preschool context. This is because they were conducted in a different socio-cultural setting. Therefore, the current findings provide direction on the role of EF observer reports in explaining emergent literacy development.

In terms of reported executive functions, not much has been done to compare direct versus observer reports to rhyme awareness. This study attempted to address this gap in literature. Although studies suggest that observer reports are easier and affordable compared to direct assessments, the data generated from such reports could be distorted by the observer's education level, expectations, mental status, cultural beliefs, competence and stereotypes (Rao et al., 2022). Observer reports are still the preferred primary source of data for cognitive development, even in the context of more standardised measures. While concerns about the reliability of observer reports continue to remain, this type of EF assessment has been supported by evidence (Allan et al., 2014a; Blair & Razza, 2007; Hooper et al., 2020; Lonigan et al., 2017; Ribner et al., 2017; Toplak et al., 2013).

The use of reported EF has been confirmed by the current study. For this age group (5 and 6 year olds) that was investigated in this study, which can be challenging to test using direct EF tests, the use of observer ratings of EF that have been well

designed and normed, would be useful. When dealing with a population of children who may present difficulties for direct assessments of EF and other cognitive functions, using observer ratings can be a cost-effective strategy for gathering reliable information on EF. To fill the knowledge gap in indirect EF assessment, this research found that using observer reports to index EF, the connections between specific EFs and rhyme awareness skills among preschool children from low-income public schools were established.

The following account for the possible explanations for the contribution of indirect executive function measures to rhyme awareness. First, research suggests that compared to other cognitive skills, it is much easier to use indirect measures to examine some domains, such as language development and fine motor skills. Second, indirect EF measures were administered in a one-on-one, individual-basis, which is less distractive compared to a group-based typical classroom approach, which places additional cognitive demands on the participant's ability to regulate their emotions, attention and behaviour (McCoy, 2019). In other words, the indirect measures were less demanding and tapped on the real-life behavioural experiences of the participants compared to the direct tests, which could activate physiological stress among children (Heissel et al., 2017; Inzlicht et al., 2012). The call for EF assessments evokes young children's everyday cognition rather than guided or abstract cognition that is captured in controlled settings, which should be the subject of future research (Jacob & Parkinson, 2015).

Third, the direct measures of EF when used in preschool children have been found to be less effective in estimating cognitive abilities than indirect measures such as the task orientation, which taps attention and motivating aspects of executive functions, which influence performance on linguistic tasks. Finally, most direct

measures of EF are limited by test impurity (the measures ability to assess more than one EF component) that has often been reported in the literature. It has been argued that the assessment format, testing environment and procedures, as well as particular test stimuli and test instructions, may be experienced differently by children and may appear strange, irrelevant, or discouraging to some children such that the examiner may assess different abilities from those that are targeted (McCoy, 2019).

Although there is no evidence that direct tests used in this study predict phonological awareness, it still remains imperative for further work on executive function performance across different assessment settings that compare individual and group assessments, which was beyond the scope of the current study (Obradović & Steyer, 2022). Such information obtained from various perspectives (direct assessment and observer reports) helps to provide a holistic picture of a specific child being assessed with the goal of collecting the assessment data at both population level and individual child level (Rao et al., 2022).

#### **6.5 Hypothesis Number 4: The Role of Executive Functions in Moderating the Effect of the Rhymes and Stories Intervention on Rhyme Awareness**

Inhibitory control (IC) in children has been shown to correlate with later academic success (Allan et al., 2014b; Willoughby et al., 2012), but the exact nature of this correlation and the impact of potential moderators is unclear. Here, the focus was to find out how EF moderated the association between rhymes and stories' intervention and rhyme awareness.

In line with the earlier stated hypothesis, executive functions (EF) specifically inhibitory control, moderated the association between rhymes and stories intervention and rhyme awareness. The findings support the hypothesis that executive functions influence emergent literacy interventions to improve initial learning outcomes like

rhyme awareness. Unlike prior studies that have established the direct and indirect role of executive functions in reading and mathematics (Blair & Razza, 2007; Nayfeld et al., 2013; Welsh et al., 2010), the present uncovered a different pathway to moderating the association between the rhymes, stories intervention and rhyme awareness. While previous research found that executive functions moderate the association between learning-related behaviours and initial literacy skills (Nesbitt et al., 2015; Sasser et al., 2015), the present study found that moderation could be achieved through initial literacy interventions that consist of rhymes and stories designed for public preschool learners. The emergent literacy intervention targeted rhyme awareness, the earliest phonological awareness skill in children that predicts reading (Goswami, 2002a; Hogan et al., 2005; Macmillan, 2002; Melby-Lervåg, 2012).

The findings of the present study may be due to the following factors. First, in the early stages of literacy development, when children are still learning the letters and sounds that make up words but before reading becomes automatic, executive function can be helpful (Fuhs et al., 2015). In addition to laying the groundwork for reading, writing, and arithmetic, executive function may also play a pivotal role in children's vocabulary and oral language development by facilitating the ability to attend to multiple informational inputs at the same time, correcting mistakes, and weigh alternatives what to focus on (Weiland et al., 2014).

Second, children's academic performance and their social behaviour were most reliably predicted by inhibitory control, one of the three types of executive functions (EF) examined here, because in contrast to working memory and other specific EF, inhibitory control is more directly able to enhance children's capacity to ignore irrelevant information and more effectively attend to classroom instruction and academic subject matter (Cain, 2006; Laski & Dulaney, 2015), and to assist in the

suppression of destructive, unfocused, or drawdown impulses (Berry, 2012). In addition, controls social interaction (Moriguchi et al., 2016).

Third, these results could mean that during the preschool years, executive functions play a critical role in facilitating learning by controlling attention (Blair, 2002; Rueda et al., 2005). Through the use of inhibitory control, the child is able to identify rhymes by focusing on the end sound and not the meaning of the spoken word. Children with adequate executive functions are able to focus on the sounds of words rather than their meaning. For other language-based tasks, it is the meaning of the word and not the sound that is important. Inhibitory control aids children to take into account the phonological rather than the semantic perspective on the relationship between words. This argument is comparable to the perspective-taking argument (Kloo et al., 2010). Children were assigned a rhyming oddity activity by Farrar et al., (2012) in which they were presented three photos, given labels, and instructed to identify the two that sounded similar. For instance, if a child was presented with photos of a *log*, a *dog*, and a *chair*, the child would have to choose the *dog* and the *log* while ignoring any meaningful relationships between the photos. Even after adjusting for age and overall language proficiency, they found that theory of mind comprehension in 4-year-olds was significantly correlated with the rhyming task. Rhyming oddity tests involve the capacity to switch quickly between various points of view. The rhyming tests used in this study required to use their inhibitory control to consciously evaluate the sound relation between words and block their meaning relationship.

Executive functions, specifically inhibitory control played a critical role in altering the effect of the intervention on rhyme awareness because children through inhibition understood that words were associated based on similar sounds rather than similar meanings in order for them to rhyme. Due to the natural tendency of young

children to automatically focus on meaning, they need inhibitory control to understand the similarity in the end sound (Farrar & Ashwell, 2012).

Fourth, learning habits in the classroom have been proposed as a mechanism connecting executive function skills with phonological awareness. Specifically, children's executive function skills may help preschools succeed in increasingly complex early learning contexts (Blair & Diamond, 2008; McClelland & Cameron, 2011). Lastly, preschool children's executive functions has been found to predict acquisition of language, literacy and socio-emotional development (Bierman et al., 2008). The role of executive functions in support vocabulary (Weiland et al., 2014) and other aspects of language such as phonological awareness (Scheepers et al., 2021; Segers et al., 2016; Yang et al., 2014) suggests that for language-based interventions, the function of executive functions will be activated. An alternative explanation suggests that language also supports EF performance (Meuwissen & Zelazo, 2014). However, Gooch and others (2016) found that although language and EF had a strong relationship, the impact of language on later EF skills (and vice versa) was weak because executive function becomes more differentiated as children grow.

A fifth explanation for the present findings is that the EF tasks that were assessed were more cognitive than behavioural. The difference between the cognitive inhibitory control and behavioural inhibitory control is that the cognitive executive functions are required for academic learning while the behavioural inhibitory control are required for good social functioning as argued by Li-Grining (2007) and Carlson & Moses (2001). This implies that for a preschool learner to be able to be aware of rhymes, they need their inhibitory control in order to focus on the required task.

Sixth, EF skills are biologically determined brain functions (the dorsolateral prefrontal, anterior cingulate and parietal cortex), which are actively developing in

preschool years (Kegel & Bus, 2014), capable of activating varied cortical regions and coordinating multiple pieces of information simultaneously. EF skills play a huge role in the coordination of the brain (Menon & D'Esposito, 2021). This capacity positions EF to enhance emergent literacy learning by regulating attention and goal-directed behaviour, which supports the acquisition of rhyme awareness skills in preschool children.

Finally, since the participants were drawn from a low-income background, socio-economic status (SES) seems to affect the results because delayed academic and social-emotional school readiness in pre-preschool is a strong indicator of future achievement gaps for children from low-income families (Blair, 2002; Ryan et al., 2006). Growing research indicates that early and middle-age delays in the development of executive functions (EFs) are correlated with poverty exposure (Raver et al., 2013). In addition, it could be that low EF skills mediate the connection between economic hardship and academic setbacks in childhood. The link between low EF, SES and emergent literacy is well established (Chung et al., 2017; Nesbitt et al., 2013).

In an attempt to relate the finding to related literature, there is need to highlight previous studies (Bierman et al., 2008) conducted in the United States of America. Prior research (Bierman et al., 2008) revealed that children who are in the intervention condition with lower executive functions exhibited increased levels of print knowledge, reduced aggression, and improved social competence. The study by Bierman et al., (2008) examined the intervention effect on five executive function skills (backward word span, peg tapping, walk a line slowly, dimensional change card sort task [DCCS] and task orientation) and found significant intervention effects only for two executive function tasks; DCCS and task orientation (Bierman et al., 2008). These studies confirm the role of executive functions in moderating the relationship between the rhymes,

stories intervention and rhyme awareness that has been found in the current study. It is worth noting that although we refer to prior studies that are consistent with the present study, the current study is unique in its own right as it focusses on a local Zambian language, a point of departure when compared to previous research that has mainly examined rhyme awareness in English and other foreign languages.

### **6.6 Gap and Purpose of the Study**

There is not much information available on the role of executive function (EF) skills in phonological awareness interventions particularly rhyme awareness among Zambian public preschool children. This topic was investigated in the context of a rhyme awareness intervention for low-income 5- to 6-year-olds. A variety of cognitive and behavioural performance tasks that tap on EF skill development were examined, as well as alternative hypotheses about how intervention effects on phonological awareness might be moderated by executive functions.

### **6.7 Thesis of the Study**

This study has established that exposing non-preschool readers to language stimulating culturally appropriate and digital-based material that is developmentally appropriate will result in improved emergent literacy skills and that this relationship is moderated by cognitive skills such as working memory and inhibitory control. Sufficient practice in a familiar language using mobile devices that attract children's attention for them to be motivated to engage in a task is important for better emergent literacy skills like rhyme awareness.

## **6.8 Broader Theoretical Bases of the Current Study**

It is necessary to discuss the findings in the context of the theory of constructivism in relation to emergent literacy and executive function development in the Zambian preschool context. Constructivism as a learning approach initially emerged from the works of Kant, Piaget, Vygotsky and Bruner. Constructivism is seen as allowing the learner to acquire knowledge through active hands-on experience. This perspective states that true learning occurs when the learner is excited about the learning experience. One of the practical ways to achieve real learning is by providing a stimulating environment. The learners to actually work hands-on. The hands matter because they are the intellect of the mind, the hands show the interest of the mind, and when the hands are extended to the target object of interest, the prefrontal cortex is activated and it lights up. This ignites the neuron activity in the brain when a learner is interested in the learning material. Most often, this happens when children are actively engaged in this process, where they have to be interested and the material needs to be meaningful for it to be mastered by the children (Yang et al., 2014).

In an attempt to apply constructivism to the current context of examining the role of executive functions in moderating the relationship between the local rhymes and stories intervention and rhyme awareness, the current study approach recognised the learner as an active participant in the learning process, then ensured that the tablet was loaded with not only exciting rhymes and stories but material that was in the local language that appealed to the participants. Another feature that could have stimulated the interest of the participants in the current study was the sensorimotor interactions such as the use of videos, voice and tactile facilities in the intervention material. The design and approach of the current study in adhering to the principles of constructivism

could have contributed to the development of rhyme awareness as a result of the moderation role of executive functions in public preschool children.

The development of executive function is determined both by social factors (Blair, 2006; Ceci, 1991; Cicchetti, 2002) and biological factors (Ferguson et al., 2021; Lloyd et al., 2021; Rennie et al., 2004; Schiff & Vakil, 2015). This justifies the discussion of the social determinants of executive functions. For the purpose of this discussion on the role of the environment on EF development, the discussion will only focus on the social factors that contribute to EF. The sociocultural theory advocates for the importance of sensitive and responsive caregiving for better cognitive outcomes. The current study found that among children from disadvantaged family backgrounds, EF is able to moderate the link between the intervention and rhyme awareness. This implies that when responsive care giving and well-designed interventions are provided, opportunities to enhance EF will be improved in accordance with the EF-AA theory that framed the current study.

It is important to talk about how executive functions affect emergent literacy development in public pre-schoolers because socio-culturally and economically deprived children tend to experience delayed cognitive and socio-emotional milestones (Cicchetti, 2002; Li-Grining, 2007; O'Connor et al., 2000). The take away message here is that to fully understand how children respond to emergent literacy interventions delivered at a low cost, there is need to pay particular attention to cognitive skills such as executive functions (Bierman et al., 2008).

## **6.9 Application of the Executive Functions–Academic Achievement (EF-AA) Theory to the Zambian Preschool Context**

In this section, the researcher critically discusses the contributions of the current theory being used to guide this study and its application to the Zambian preschool context. This will be followed up by a discussion of the sociocultural theory in an attempt to address the need for a more realistic and flexible model that will account for a modern theoretical framework for Zambian children enrolled in the public preschools.

Application of this theory among preschool-aged children enrolled in public schools in post-colonial Zambia is not devoid of challenges on account of the theory's non-cultural universality. First, cognitive development is influenced by not only people, language and culture but also other factors such as computers, child learning support systems, attachment, stress, caregiver income and education, quality of child care practices disease, nutrition and child abuse (Brudevold-Newman et al., 2018). For instance, rampant negative vices evident in Zambian society today such as child marriages have had devastating effects on the cognitive abilities of children, thus depriving them of the educational opportunities that they are supposed to enjoy (Kaunda & Ailwood, 2021; Matafwali & Chansa-Kabali, 2017; McCoy et al., 2015).

Second, the massive attack on the Zambian languages caused by the infiltration of the English language in the modern Zambian society, referred to it as a language that works against educational achievement for local learners who are familiar with Chinyanja (Linehan, 2005; Williams, 1996), is yet another challenge that warrants discussion as we analyse executive functions contribution to local languages in Zambia. The effect of English medium of literacy instruction on Zambia early grade learners has been devastating for their acquisition of literacy skills (Williams, 1996). On the other hand, English has been accused of contributing to the negative perception of Zambian languages as inferior to English (Mbewe et al., 1996), use of town Chinyanja as opposed

to standard Chinyanja (Tambulukani, 2015) and children tend to substitute *Chinyanja* letter sounds with English letter names (Ojanen, 2007).

The other unresolved issue about language is that it is shared in most collectivistic cultural settings in sub-Saharan African (Tsamaase et al., 2020). Whereas caregivers in Western contexts expect verbal responses “reciprocal communication” from their children, caregivers in Botswana (Tsamaase et al., 2020) and Nigeria (Zeitlin, 1996), expect their children to understand more than respond in a conversation consistent with the instructional manner in which language is used by caregivers in Zambia. In view of this cross-cultural difference with regard to language, the Western view of the role of language in child development is difficult to settle in sub-Saharan African societies like Zambia where language is used differently. This means that studies like the current one are necessary to provide more information on the local languages which have been neglected in the cognitive development studies.

Third, although collectivistic societies have been shown to have better executive function outcomes (Schmitt et al., 2019), the influence of individualistic culture on the Zambian collectivistic culture threatens Zambian’s cultural influence on executive functions. Unfortunately, modern Zambian families, perhaps due to economic reasons, no longer appreciate the extended family system, where children are supported by other family members in addition to their biological parents and siblings towards attainment of cognitive abilities such as shared reading, language, self-control, creativity and problem-solving (Kalindi et al., 2018; Mooya et al., 2016). In addition to the decline of the extended family system, the current inherited Western public preschool curriculum in current practice is challenging as it promotes values that alienate learners from their indigenous culture (Serpell & Jere-Folotiya, 2008). More recently, Tsamaase and colleagues (2020) have found that there are different value expectations between the

standard preschool curriculum and what caregivers wish for their children in Botswana. This mismatch has also been reported in Uganda, Kenya and Zambia (Ejuu et al., 2019; Ng'asike, 2014; Serpell & Jere-Folotiya, 2008). The argument here is that executive functions in the Zambian cultural setting need further investigation. The current study is such an attempt to provide further information on executive functions and Zambian culture.

Fourth, application of the current theory in its current form to the Zambian context is problematic because it does not take into account other factors that affect cognitive development in children such as task and object familiarity, the socio-economic status of the child and emotional regulation. Task and object familiarity among low-income urban primary school learners has been found to affect visual perception (Serpell, 1979). The high poverty levels in Zambia have forced families to spend more of their energies on economic activities at the expense of cognitive stimulating activities such as dialogic book reading to young children (Havigurst and others, 2004). Studies have shown the relation between emotional regulation and executive function, a proxy of cognitive development (Reilly & Downer, 2019). However, the current theory is silent on this issue.

Last of all, the cynical one-liner view in the current theory of the availability of cognitive resources of adaptation (Kalindi et al., 2018), like books and other learning materials, teachers and parents, is not only problematic but also inconsiderate of deprived contexts experienced by most Zambian public schools where the inadequacy of teaching and learning materials is a real issue (Tambulukani & Bus, 2012). For instance, currently there are limited numbers of preschool teachers in public preschools (Munsaka & Kalinde, 2017). The take home argument here is that Western developed theories, like the one informing this study have been tested on Western preschool

children who do not share the same educational opportunities, materials and infrastructure with Zambian children. This suggests that there is need to assess these Western theories based on the real-life experiences of local Zambian children, if reliable conclusions can be made. The aim of this study was to apply the EF-AA theory proposed by Nesbitt and colleagues (2015) to the Zambian Preschool context.

### **6.10 Summary**

Overall, the primary goal of this research was to examine the interrelationships among executive functions as measured directly and by observers, the rhymes, stories intervention and rhyme awareness in public preschools in Zambia who were five and six years old. This study also used both direct and indirect EF measures because indirect tests are often mentioned but are under-researched in most emerging literacy studies and it turned out that not only did executive functions develop over time, but they were related to rhyme awareness in *Chinyanja*. Indirect tests proved to be better predictors of rhyme awareness compared to direct measures. In addition, after adjusting for key socio-demographic covariates, EF significantly moderated the relationship between the intervention and rhyme awareness skills.

## CHAPTER SEVEN

### CONCLUSION AND RECOMMENDATIONS

#### 7.0 Overview

This chapter presents a summary of the research aims and findings, the contributions and limitations of the study. Furthermore, opportunities for future research and other recommendations have been highlighted.

#### 7.1 Summary of Objectives and Findings

Despite the overwhelming evidence that older children's executive function (EF) skills play a crucial role in facilitating phonological awareness and other language abilities, not much is known about the moderation effect of EF skills on the link between local digital emergent literacy intervention (rhymes and stories) and preschoolers' rhyme awareness development in socioeconomically disadvantaged learners in Zambian public preschools. This study, filled the gap by using hierarchical regression on data from 375 preschoolers (5 and 6 years old) to investigate four objectives. The first objective was on the performance on four EF tests of preschoolers at the start and finish of preschool. The second was on the links between executive functions and rhyme awareness skills while the third, the contribution of the two types of assessments to rhyme awareness: performance-based and observer reported EF measures. Lastly, the role of EF skills on the link between emergent literacy intervention (rhymes and stories) and preschoolers' rhyme awareness. After controlling for different covariates, the study found that EF skills at the beginning of preschool significantly improve as children transitioned to Grade One, executive functions were significant predictors of rhyme awareness skills, and observer reported EF measures better predicted rhyme awareness than performance-based measures. In addition, EF skills were able to moderate the link

between local digital emergent literacy intervention (rhymes and stories) and preschoolers' rhyme awareness. Our results point to the importance of EF in promoting the development of rhyme awareness skills in preschoolers enrolled in deprived public schools. These results also provide a clear direction for improving the most basic emergent literacy skills such as rhyme awareness. This conversation highlights the need for more investigations into better local digital emergent literacy interventions for encouraging the development of phonological skills in preschool-aged children learning in public schools.

This study was aimed at evaluating the role of executive functions on the influence of the intervention (rhymes and stories) on phonological awareness in public preschool learners in three districts in Lusaka Province. This study found that executive functions, particularly inhibitory control, moderated the effect of rhymes and stories on rhyme awareness. Furthermore, the study sought to find out whether executive functions predict phonological awareness. The data suggests that executive functions were strong predictors of phonological awareness. In addition, the contribution of both behavioural and cognitive measures of executive functions towards overall executive functions were compared and it was found that adult reported measures were better predictors of executive functions than direct assessment measures of executive functions. The current study also followed up learners from the time they were enrolled in preschool all the way up to the time they were in Grade One to find out their performance on various executive function tasks. The study established that executive function performance from preschool to grade one significantly improved.

A plausible explanation for the role of executive functions in moderating the relationship between intervention (rhymes and stories) on phonological awareness

(rhyme awareness) is that the pre-schoolers learn to detect rhymes more easily as a result of exposure to rhymes and stories that increase their attention.

## **7.2 Significant Original Contribution to Knowledge (SOCK)**

The present study findings emphasize the importance of cognitive abilities such as executive functions during language and literacy instruction especially for children who have experienced delays in executive function development. The following section discuss different ways in which the current study makes a significant original contribution to knowledge.

First, the findings of the current study have helped to demonstrate that the prevalent reading problems in Zambia among early grade learners can be addressed by examining the poor literacy levels from the executive function perspective. Identifying the role of executive functions in emergent literacy development is one of the initial steps to designing effective interventions that promote cognitive development for school success in Zambia (McCoy et al., 2015).

Second, the study makes a unique theoretical contribution by testing a framework that emphasises the role of executive functions in emergent literacy interventions in preschool children specifically on rhyme awareness, a phonological awareness skill at the elementary stage. While the direct effect of executive functions on emergent literacy has been widely recognised (Cartwright, 2012; De Franchis et al., 2017; Foy & Mann, 2013; Hooper et al., 2020; Mulder et al., 2017; Zhang et al., 2017), the moderation effect of executive functions via emergent literacy interventions on phonological awareness as demonstrated in this study is interesting. These findings could contribute to enactment of laws and generation of funds for cognitive development programmes in public preschools in Zambia. This could encourage efforts

consistent with the United Nations Sustainable Development Goals (SDGs) that promote widespread understanding of the significance of the early years for individual and social development (Rao et al., 2022).

Third, the degree to which the findings of this study are generalisable to the general preschool population in Zambia serves as another significant original contribution to knowledge. The results of the study could not be generalised to other provinces of Zambia because the study was based on only 14 schools in Lusaka province. Although this is a study limitation, it provides information that is original and able to contribute to the socio-cultural and economic wellbeing of the study participants.

Fourth, the study that demonstrated the role of executive function in the development of emergent literacy skills among Zambian public preschool learners from low- and middle-income backgrounds. Through this study, an enhanced understanding of the learning environmental challenges in a typical public Zambian preschool setting was achieved. Teachers in this context faced several challenges including overcrowded classrooms, less effective literacy teaching methods, inadequate teaching and learning materials, poor physical infrastructure and less effective monitoring and evaluation mechanisms for quality assurance on the part of public-school inspectors.

Fifth, the present study made a unique contribution to knowledge by identifying the knowledge gap in the literature and addressing such gaps. Through various literature review search strategies, the study found that there were few or none of the intervention studies conducted in Zambia at the preschool level that addressed the role of executive function in emergent literacy interventions. This finding enabled the study to address this knowledge gap by conducting such an intervention study.

Sixth, the methodology of the current study was another avenue through which the study made its unique contribution to knowledge. On one hand, the study employed moderation statistical analysis on the first cohort of the Zambian public preschool population after the introduction of early childhood education in Zambia. This model was unique and used for the first time, making it an original contribution to knowledge in the field.

Seventh, carefully developing technology enhanced culturally appropriate rhymes and stories and testing them out to find out how they help to stimulate rhyme awareness in Zambian preschool learners is in itself an original contribution to knowledge that is not only rare in the Zambian context but also expensive to implement for the Ministry of Education, which experiences low funding for its early childhood programmes. In addition, the effective and successful use of a longitudinal between-subjects experimental research design is also another contribution to the field. This is a rare but robust research approach. Longitudinal between subjects experimental designs are gold standards of research that provide an in-depth understanding of children (Fuhs et al., 2014; Gandolfi et al., 2021).

Eighth, this study makes a significant original contribution to knowledge by testing the applicability of executive function tests in the Zambian public preschool context where classrooms are overcrowded, learning materials are scarce, teachers are inadequate, monitoring and supervision in the preschools is below expectation (Kaunda & Ailwood, 2021; Tambulukani & Bus, 2012). Furthermore, the study attempts to fill the gaps in the Zambian literature on the effect of digital rhymes and stories on brain functioning in preschool learners. Most of the Zambian caregivers and parents are now sharing their mobile phones with their young children, who mostly entertain themselves by playing stories from YouTube and other child-friendly applications. Despite this

situation, no study has been conducted to investigate this phenomenon, at least, during the time when the current study was conducted (Ojanen, Ronimus, et al., 2015; Walubita et al., 2015).

Nineth, when all original efforts evident in the present study are brought together, it is clear that the study made a significant original contribution to knowledge by identifying the knowledge gaps in the literature, building a non-existent conceptual theoretical framework, developing an effective tested statistical model that clearly demonstrates the role of executive function in the relationship between the rhymes, stories intervention and phonological awareness in Zambia preschool children.

Tenth, rhymes and stories administered in the local language provide appropriate socio-cultural opportunities for children to practice the local languages for effective acquisition of initial literacy skills that later contribute to reading development.

Eleventh, the relationship between phonological awareness and executive functions noted in this study suggests that executive functions facilitate the development of emergent literacy skills that are important for reading acquisition among public preschool learners who are starting to read.

Twelveth, executive functions like any other cognitive skills grow with age. Thus, developmentally appropriate academic tasks should be provided in the public preschool setting, especially when learners transition from preschool to Grade One.

Thirteenth, the data in this study suggests that for preschool children, adult-reported measures of executive functions seem to provide a reliable index of cognitive development compared to directly assessed measures because in young children, executive functions could be immature. Furthermore, local reliable and ecological validated executive function assessment tools developed and tested in the present study

are tangible contributions to the field of cognitive assessment in Zambia where assessment tools used in child development research have a Western origin that tend to produce culturally biased results.

Fourteenth, another concrete contribution of this study is the supply of android supported computer tablets installed with local rhymes and stories that have been donated to the participating schools for use after the completion of the current project. These cost-effective technology-enhanced learning resources will be used by preschool teachers to instruct literacy and language skills in a public preschool that mostly experienced difficulties in accessing learning materials that are both cultural and age appropriate. There is no doubt that digital literacy and language intervention programmes are not only easily scalable due to their low cost but they are also exciting and engaging for young learners.

Fifteenth, arising from the present study is a high quality peer-reviewed paper (research output) that has been published in a high impact peer-reviewed academic journal that documents the latest and cutting-edge research on cognitive, language and literacy development. Peer-reviewed papers contribute to knowledge generation, academic promotions and research consultancy opportunities both for the individual author(s) and the university to which the authors are affiliated. In this case, the student of this thesis and the supervisors of this paper are drawn from both an African and a European University, offering a strong partnership of different cultural and technological orientations with a varied number of lessons to learn.

Finally, the present investigation is one of the first in Zambia, specifically in Lusaka Province schools to show that executive functions moderate the relationship between local Chinyanja rhymes and stories and rhyme awareness in public school learners. This study has provided data demonstrating the role of specific components of

executive functions – inhibitory control in phonological awareness development particularly rhyme awareness. The other knowledge gaps identified and addressed in this study are focused on adult-reported assessment approaches as better indexes of estimating executive functions in young children. This is mentioned with consideration of the varied child measures of executive functions in existence. The use of a longitudinal research design to examine the development of executive functions in preschool and Grade One school children is one way of bridging the current literature gap on well-designed experimental studies in the Zambian preschool context.

### **7.3 Limitations of the Study**

Although the current study boasts of several strengths – the longitudinal design, local language-based experimental intervention study with two active control conditions, use of well-designed digital local rhymes and stories, focus on public preschools post-implementation of a new literacy policy, focus on multiple classrooms located in rural and urban areas, the study's use of standardised measures of both EF and emergent literacy, its examination of a wide range of EF skills assessed by various tests including digit span, pencil tap, task orientation and child-friendly Stroop test, and its sufficient sample size and adjustment of several key covariates in our hierarchical regression in order to reduce the influence of certain confounders on the results – there were limitations that deserve to be noted that provide opportunities for future studies. First, the use of simple random sampling, instead of stratified randomisation denied the study the opportunity to capture equal numbers in each experimental condition. Second, the study did not separate the stories from the rhymes in the intervention. Although combining rhymes and stories was used to elicit engagement, the differential effects of

rhymes and stories on phonological awareness could not be achieved in the current study. This should be explored in future research.

Third, regression analyses used in the present study do not provide inferences on causality rendering these findings non-conclusive on whether the executive functions or targeted intervention caused improved phonological awareness skills. Fourth, although the study included participants with diverse family backgrounds, the data analysed was based on a limited sample size where only three districts were sampled. Data collected from a large sample including all the districts in Zambia would be ideal.

Fifth, while the study accounted for possible confounding variables such as age, sex, school, district and income, teacher and parental education influences were not controlled. It would be beneficial for future studies to investigate teacher and parental factors that influence phonological awareness development. Sixth, although keeping young children engaged and focused during exposure to the same material for 6 weeks was difficult when they are surrounded by natural distractions, the current study was able to establish that young children easily get bored when exposed to the same material repeated times, an issue that could form the basis for future research.

Sixth, while this research contributes to the existing literature on the topics of executive functions, early literacy digital local language interventions and rhyme, it does so with a number of caveats that include the use of Western-developed executive functions that could generally overlook the cultural affordances of children from a non-Western context.

Finally, although the executive function tests in the current study were administered in a quiet, less distractive environment in order to maximise the attention and performance of the participants, administering tests in such a manner may not be

extended to conditions under which children typically deploy their executive functions. In other words, the conditions in which the tests were administered are naturalistic enough to elicit natural behaviour. Future investigations should include conditions that provide opportunities for children to exercise control over their everyday interactions, distractions, temptations and cognitive demands (Obradović et al., 2018). The home environment should be extensively studied regarding the influence of executive functions on rhyme awareness. The home environment rather than the school tends to provide a much more accurate picture of childhood executive functions and behaviour problems.

#### **7.4 Implications of the Current Study**

The importance of this study for policy, practice and future research is discussed in the following section. This section will be segmented into practical and theoretical implications. While practical implications refer to the direct impact of the current results on policy and practice, theoretical implications will discuss the influence of the results on cognitive, literacy and language theories.

The implications of the current study are classified into three levels. These are national, institutional and individual significance of the study. At the national level, the study will inform stakeholders of the need to include executive function in the current early childhood curriculum so that teachers can prioritise the development of this set of skills that enable preschool learners to easily learn and adapt to the classroom setting, an environment that youngest learners find to be intimidating and stressful. With regard to the institutional significance of the present study, information generated from the study could enlighten the current teacher education programmes in universities and colleges of education to place emphasis on the need to prepare teachers on how to

improve executive function skills of young learners. At the individual level, the findings of the study might also help to uncover learning opportunities of technology enhanced tools for young learners in Zambia.

### **7.5 Practical Implications**

Culturally appropriate digital literacy and language instructional materials like stories and rhymes developed in the current study would be used by preschool teachers in public schools, which do not have teaching and learning materials in the language of instruction. These materials will attempt to address the current shortage of teaching and learning materials in Zambian public preschools (Serpell et al., 2017; Tambulukani & Bus, 2012) that are annexed to existing primary schools. The current scenario where preschools are attached to existing primary schools suggests that the implementation of early childhood education in Zambia was not well planned because it was mainly inherited from the colonial government (Serpell et al., 2017). The second practical implication of this study is that the cognitive and literacy assessment tools generated from this study could be further developed into screening tools for assessing children's school readiness skills making a transition for preschool to Grade One. This provision of locally developed assessment instruments in form of the ones that this study developed will help to mitigate the lack of developmentally and culturally appropriate tests in most assessment centres in Zambia (Matafwali & Serpell, 2014; Serpell & Simatende, 2016; Zuilkowski et al., 2016).

Third, some researchers in Zambia have recommended for revisions to the current preschool curriculum that would incorporate phonological awareness training for all learners (Mwanza-Kabaghe, 2015a; Thomas & Thomas, 2009). Other investigators have shown that phonological awareness instruction can help minimise

the number of learners with reading problems in primary school (Berninger et al., 1987; Matafwali & Bus, 2013; Scheepers et al., 2021).

Fourth, it is clear from the results of this study that EF is not only fundamental for emergent literacy interventions for learners from low-income backgrounds, but it also helps to prepare children for formal schooling. The findings confirm the assertion that preventative interventions that focus on EF skills tend to improve children's academic abilities such as emergent literacy, and these findings also provide new insights into the possible mechanism of improving both emergent literacy interventions and EF skills for better rhyme awareness outcomes. While most of the previous research has paid attention only to the outcomes of either emergent literacy or EF interventions, little was known until now that EF moderates the relationship between rhymes, stories and rhyme awareness. This study suggests that children would benefit from an environment that fosters the development of both EF and rhyming skills for them to benefit from the educational experience.

Fifth, this study provides information that could be used by teachers, parents and other stakeholders to improve educational programmes that support the development of early inhibitory control and phonological abilities especially in preschool. The significant relationship between executive functions and phonological awareness found in the present study suggests that strengthening the development of executive functions among public preschool learners is the initial step towards supporting their academic achievement. Executive functions in children especially those in preschool, provide a strong foundation on which other academic skills such as vocabulary, emergent literacy and maths can be built (Blair, 2002; McClelland, Cameron, Connor, Farris, Jewkes & Morrison, 2007; McClelland, Acock & Morrison, 2006; Blair and Raver 2015).

Sixth, the relationship between executive functions and the phonological awareness established in this study is critical in light of the Zambian Ministry of Education's efforts to improve emergent literacy learning outcomes in public preschoolers. These efforts include the introduction of early childhood education in public schools and the use of the local language for instruction in early childhood classrooms. These efforts have been successful especially with the introduction of public early childhood education. It has been found that in Zambia participation in early childhood education positively predicts executive functions (McCoy, Zuilkowski, Yoshikawa & Fink, 2017). In addition, the use of the local language in literacy instruction among Zambian early grade learners is effective in improving letter sound knowledge and basic reading outcomes (Sampa, 2016). From these success stories, it is clear that when Zambian preschool children are provided with the appropriate language of instruction and high-quality early educational experiences, emergent literacy outcomes are guaranteed. Exposure to culturally appropriate animated, digital stories could be considered to be a language and literacy instructional method that should help emergent literacy and language outcomes in early grade learners (Barzillai et al., 2017; Boyce et al., 2010; Isbell et al., 2004; Pace, 1992; Rieg & Paquette, 2009; Verhallen et al., 2006).

Seventh, the preschool years form the most crucial stage in child development for brain growth, which translates to development across all domains namely; physical, socio-emotional, cognitive and psychosocial (Li-Grining et al., 2007; Sasser et al., 2015). This means that EF and rhyme skills should be sustained from an early age so that they can contribute to future success in school (Neuenschwander et al., 2012).

Finally, the implications of the moderating role of executive functions in rhyme awareness offers evidence for the importance of developing cognitive abilities in children, as well as their relevance in the planning and evaluation of school readiness

and emergent literacy programmes. Executive functions, it can be argued, predict how children will respond to not only to initial literacy interventions but also the school curriculum. This may help to explain how learning and development proceeds in public preschool learners from disadvantaged families. As a result, interrogating EF skills could influence preschool interventions, which could later help to improve the literacy intervention strategies used by teachers. Early childhood education research in Zambia should prioritise the development of interventions that improve PA abilities in order to better equip children to acquire reading skills and so succeed in school. This would be one way of ensuring that children who enter formal schooling are not left behind. In addition to the practical implications, the findings of this study have relevant theoretical ramifications discussed in the next section.

## **7.6 Theoretical Implications**

Four theoretical contributions arise from the present study. The first contribution of the study results is towards the extension of cognitive developmental theory. For instance, the study results suggest that Vygotsky's socio-cultural perspective to literacy and language should be revisited. It is not only culture, language and people that result in optimal cognitive development, the type of assessment instrument (direct or reported) used to examine cognitive development should be considered also for a comprehensive view of cognitive development in Zambian children. The present study results, in line with other related studies advances the theoretical position that for children, reported measures of cognitive skills are better predictors of cognitive development than direct measures.

Second, the study's rare attempt to document and preserve cultural resources in form of stories and rhymes that have been developed with the local realities in mind

need to be supported because such material currently exists in oral traditions that are inaccessible to the present generation of public preschool learners in Zambia.

Third, the current study findings suggest that different inhibitory processes are available even at very young ages (Gandotra et al., 2021). Furthermore, these findings promote the potential predictive value of various executive function abilities in explaining emergent literacy development. This area of research has received attention in literature.

Finally, the current study, being one of the few initial literacy and language digital interventions since the introduction of the new literacy and language policy in 2014 (Banda & Mwanza, 2017b, 2017a) is able to show that well-designed and delivered technology-enhanced initial literacy self-paced learning resource holds promise for wide use in low-resource preschool classrooms in public schools. This study also suggests that the positive effect of literacy and language interventions delivered via tablet technology are moderated by cognitive skills such as working memory and inhibitory skills. These executive function skills are capable of coordinating not only literacy and language areas of the brain but also audio-visual brain areas (Carlén, 2017; Fuster, 2015; Miller & Cohen, 2001).

## **7.7 RECOMMENDATIONS**

This study examined whether Zambian preschool children's executive function skills moderated the relationship between rhymes and stories intervention and rhyme awareness. The extent to which specific assessment approaches used to measure executive functions predicted rhyme awareness was also examined. Four different EF measures were used, one is classified under the observer-reported EF measures and the other three belonged to the performance-based tests namely, (a) Stroop test that

assessed inhibitory control; (b) Pencil tap test assessed interference suppression; (c) Forward digit span assessed working memory; and (d) Task orientation measured attention. Results indicated that Zambian pre-schoolers' executive functions (inhibitory control) moderated the associations between the rhymes and stories intervention and phonological awareness specifically; rhyme awareness. Based on these findings, recommendations for early childhood education in Zambia are given below. Early childhood stakeholders should consider the following relevant recommendations:

First, the moderation by learners' executive functions observed in the current study implies that preschool teachers need to fully understand and nurture executive functions such as working memory, inhibitory control and cognitive flexibility in public preschool learners.

Second, computer-based phonological awareness training namely, rhyme awareness should be promoted during preschool years in the public preschools in an attempt to improve the poor literacy levels in Zambia. Phonological awareness training should take the form of exposure to indigenous language-based rhymes and traditional stories situated within the socio-cultural context of the learners.

Third, the current study confirmed the practical use of computer technology in packaging learning materials for preschool learners. Particularly, tablet computer technology that supports android applications should be considered when designing teaching and learning resources.

Fourth, the current finding that executive functions improve with age imply that the curriculum in the public preschool Zambian context should be age and culturally appropriate for effective teaching and learning.

Fifth, executive function assessment tools used in the present study have the potential for use in public preschools as screening tools for learners moving from

preschool to Grade One. This could be one of the most reliable methods to monitoring and evaluating cognitive abilities using tools that have strong psychometric properties in the public preschools. These tools have so far been used in two major early childhood studies namely, the present study and the prior early childhood development project (Fink et al., 2012).

Finally, the current study used one of the recommended Zambian local languages commonly used in the sampled schools as one way of responding to the current Ministry of Education language of instruction policy. The use local languages in public preschools should be encouraged to promote emergent literacy acquisition (Chansa-Kabali, 2015; Hazwela, 2016; Kaunda & Ailwood, 2021; Kula & Mwansa, 2022; Lyytinen et al., 2019; Matafwali, 2010; Musonda, 2011; Sampa et al., 2018) as well as the provision of appropriate local language learning materials to all children enrolled in public schools should be implemented.

## **7.8 Future Research**

As a way forward, it is hoped that this work and the easily accessible intervention programme developed in the current study will inspire additional research into the effects of rhymes and stories in other phonological awareness components such as syllable awareness, word awareness and phonemic awareness in primary and preschool school learners enrolled in both public and private schools in Zambia.

Second, future research should also include investigation of specific components of executive functions such as working memory and cognitive flexibility and their impact on syllable awareness, word awareness and phonemic awareness of high income varied populations, as the current study was mainly focused on inhibitory control and rhyme awareness in children from low-income backgrounds.

Third, future work needs to follow-up this study by investigating the potential of rhyme awareness as an emergent literacy teaching method although studies confirm the assertion that due to the consistent *Chinyanja* orthography, letter-sound correspondence is the recommended literacy instruction approach. Currently, there is a predominant focus on syllable awareness and grapheme-phoneme correspondence as teaching methods for literacy acquisition.

Fourth, it will be important for future studies to consider examining the impact of emergent literacy interventions on the executive functions of preschool children drawn from more diverse and representative populations such as refugees and other out-of-school children. This could be an attempt to effectively facilitate by the use of culturally-sensitive group level EF tests.

Finally, a focus on the relationship between rhymes, later reading and spelling performance among Zambian pre and primary school children is needed in future studies.

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## APPENDICES

### Appendix 1: Ethical Clearance



## THE UNIVERSITY OF ZAMBIA

### DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Great East Road | P.O. Box 32379 | Lusaka 10101 | Tel: +260-211-290 258/291 777  
Fax: +260-1-290 258/253 952 | Email: director@drgs.unza.zm | Website: www.unza.zm

#### Renewal of Study

14<sup>th</sup> June, 2019

**REF NO. HSSREC: 2018-FEB-001**

Dr. Beatrice Matafwali  
University of Zambia  
School of Education  
Department of Educational Psychology, Sociology and Special Education  
Box 32379  
**LUSAKA**

Dear Dr. Matafwali,

**RE: "EFFECTS OF STORIES AND RHYMES PRESENTED THROUGH ELECTRONIC MEDIA ON LANGUAGE AND LITERACY SKILLS AMONG PRE-SCHOOL AND FIRST GRADE LEARNERS IN ZAMBIA"**

Reference is made to your application for extension of study. The University of Zambia Humanities and Social Sciences Research Ethics Committee IRB resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	Ordinary /Expedited Review	Approval No. REF No. HSSREC: 2018-FEB-001
Approval and Expiry Date	Approval Date: 14 <sup>th</sup> June, 2019	Expiry Date: 13 <sup>th</sup> June, 2020
Protocol Version and Date	Version- Nil	13 <sup>th</sup> June, 2020
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version	To be provided
Recruitment Materials	Nil	Nil

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Excellence in Teaching, Research and Community Service

There are specific conditions that will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

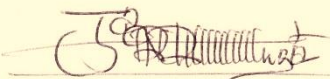
#### **Conditions of Approval**

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to the IRB within 5 days.
- All protocol modifications must be IRB approved by an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review and approval. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by the IRB before they can be implemented.
- All protocol deviations must be reported to the IRB within 5 working days.
- All recruitment materials must be approved by the IRB prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. Documents must be received by the IRB at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Any documents received less than 30 days before expiry will be labelled "late submissions" and will incur a penalty.
- Every 6 (six) months a progress report form supplied by The University of Zambia Humanities and Social Sciences Research Ethics Committee IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- The University of Zambia Humanities and Social Sciences Research Ethics Committee IRB does not "stamp" approval letters, consent forms or study documents unless requested for in writing. This is because the approval letter clearly indicates the documents approved by the IRB as well as other elements and conditions of approval.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of The University of Zambia Humanities and Social Sciences Research Ethics Committee (IRB), we would like to wish you all the success as you carry out your study.

Yours faithfully,



*Dr. Jason Mwanza*

BA, MSoc, Sc., PhD

**CHAIRPERSON**

**THE UNIVERSITY OF ZAMBIA HUMANITIES AND  
SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE IRB**

cc: Director, Directorate of Research and Graduate Studies  
Assistant Director (Research), Directorate of Research and Graduate Studies  
Assistant Registrar (Research), Directorate of Research and Graduate Studies  
Senior Administrative Officer (Research), Directorate of Research and Graduate Studies

**Appendix 2: Approval from Ministry of Education, District Office**

All correspondence should be addressed  
to the District Education Board Secretary

Telephone: 0211-240250 240249 0955 623749  
Email: desbsiska@yahoo.co.uk



DEB/LSK/10/1/19

REPUBLIC OF ZAMBIA

**MINISTRY OF GENERAL EDUCATION**

DISTRICT EDUCATION BOARD SECRETARY  
P. O. BOX 50297  
LUSAKA

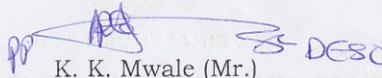
16<sup>th</sup> June, 2017

The Headteacher  
.....Primary School  
**LUSAKA**

**RE: REQUEST TO CARRYING OUT AN ACADEMIC RESEARCH**

This serves to introduce to you Mr. Gabriel Walubita, a Lecturer wishes to conduct a research on the school information on Early Childhood schools in Lusaka District. He has been granted permission to carry out his research in your school.

Kindly welcome and give him all the necessary support accordingly.

  
K. K. Mwale (Mr.)

**DISTRICT EDUCATION BOARD SECRETARY  
LUSAKA DISTRICT**


ts\*

### Appendix 3: Approval from Ministry of Education, Provincial Office

All communications should be addressed to the Provincial Educational Officer and not to any individual by name

Telephone: +260 - 211 - 250655 / 251220  
Fax: +260 - 251009

In Reply please quote:  
No:.....  
PEO/LR/101/28/2



REPUBLIC OF ZAMBIA

MINISTRY OF GENERAL EDUCATION

OFFICE OF THE PROVINCIAL EDUCATION OFFICER  
LUSAKA REGIONAL HEADQUARTERS  
PRIVATE BG RW 21E  
LUSAKA

12<sup>th</sup> October, 2017

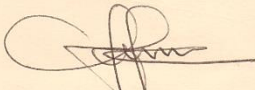
The University of Zambia  
School of Education  
P.O. Box 32379  
LUSAKA

**RE: REQUEST TO CONDUCT RESEARCH IN EARLY CHILDHOOD SCHOOLS  
IN LUSAKA PROVINCE**

Reference is made to the above subject matter.

This office is in receipt of your letter dated 8<sup>th</sup> October, 2017 in which you were seeking permission to conduct a research in Early Child Schools in Lusaka Province.

I write to inform you that permission has been granted for you to carry on the research in Lusaka Province.



Paul. Ngoma  
PROVINCIAL EDUCATION OFFICER  
LUSAKA PROVINCE  
/km

## Appendix 4: Background Information Questionnaire

### Demographic information of the child

Child's Surname		Child's first name	
Child's birth date	Date: _____ Month: _____ Year: _____		
District:	School:		
Sex	<input type="checkbox"/> Male <input type="checkbox"/> Female		
Primary language spoken by child in home	1. <input type="checkbox"/> Nyanja    2. <input type="checkbox"/> Bemba    3. <input type="checkbox"/> Tonga    4. <input type="checkbox"/> Lozi 5. <input type="checkbox"/> Other _____		
Assessor Name		Day 1	Start time: End time: Date:
		Day 2	Start time: End time: Date:

### Demographic Information of the Caregiver

Parent/Guardian full name				
Child's birth date	Date: _____ Month: _____ Year: _____			
Sex of child	<input type="checkbox"/> Male		<input type="checkbox"/> Female	
Parent/Guardian phone number				
District:			School:	
Sex				
Primary language spoken by child in home	<b>1. <input type="checkbox"/> Nyanja    2. <input type="checkbox"/> Bemba    3. <input type="checkbox"/> Tonga    4. <input type="checkbox"/> Lozi</b> <b>5. <input type="checkbox"/> Other _____</b>			
<b>Assessor Name</b>		<b>Day 1</b>	Start time:	Date:
			End time:	
		<b>Day 2</b>	Start time:	Date:
			End time:	

## Appendix 5: Executive Function Tests

### TASK ORIENTATION

*Rate each child on each of the following based on your observations during the ENTIRE assessment period. Circle the number that corresponds to the statement that best describes the child's behaviour.*

1. Pays attention to instructions and demonstration
  - a) Child spends most of time off-task, inattentive.
  - b) Child's attention frequently drifts and requires frequent prompts.
  - c) Child's attention occasionally drifts, particularly at the end of activities, but is responsive to prompts.
  - d) Child looks closely at pictures to distinguish between them. Child attends to and complies with interviewer.
2. Careful, interested in accuracy
  - a) Child is frequently haphazard and unfocused when answering items.
  - b) Child is careless at times.
  - c) Child is generally careful but interest flags, particularly at end of testing session
  - d) Child takes the time to look and appears to make thoughtful choices, particularly on hard items
3. Sustains concentration; willing to try repetitive tasks
  - a) Child not able to concentrate or persist on much of the assessment.
  - b) Child frequently distracted, requires multiple prompts from tester.
  - c) Child occasionally distracted but generally persistent, but does not require prompt from tester.
  - d) Child able to concentrate and persist with task, even toward end of tasks and with distractions.
4. Is careless or destructive with test materials
  - a) Child gets too "rowdy" with materials and breaks or damages test materials.
  - b) Child is repeatedly careless but does not damage materials, paper. Needs repeated reminders.
  - c) Child is careless or slightly destructive one time. Can include kicking, dropping object on floor "by mistake."
  - d) Child is not careless and is not destructive.
5. Can wait during and between tasks
  - a) Child is impulsive throughout assessment, needs lots of boundary-setting; transitions between tasks made difficult because of child's activity level/impulsivity.
  - b) Child is often impulsive across multiple tasks or highly impulsive during one activity; child needs multiple prompts to wait while tester gathers materials for new task.
  - c) A few instances of impulsive behaviour; child sometimes shows anticipation for interesting task materials but rarely needs a reminder.
  - d) Child waits before pointing to materials, reaching for blocks, etc., and waits patiently for new tasks to begin; no ambiguous or impulsive behaviours.
6. Remains in seat appropriately during test
  - a) Out of seat frequently or difficult to manage (e.g. runs around room, climbs on furniture).
  - b) Needs multiple reminders to return to seat, sit up but listens and responds to prompts.

- c) Gets out of seat 1x (including sliding off chair), returns to seat when prompted.
  - d) Does not climb, open closets, grab objects. (Occasional adjustment in body position is appropriate)
7. Alert and interactive; is not withdrawn
    - a) Child seems “shut down” and difficult to engage in starting task.
    - b) Child repeatedly withdraws from testing situation and needs encouragement to finish task.
    - c) Child generally interacts, but at times turns away, lowers head, takes “break” from interaction.
    - d) Child participates in interaction; body posture suggests relaxed engagement with the interviewer
  8. Cooperates; complies with tester’s requests
    - a) Child does not cooperate even when tasks are easy.
    - b) Child shows significant resistance, noncompliance and needs multiple prompts to get through assessment.
    - c) Child shows minor indications of resistance, boredom (e.g. frowns, sighs) but completes tasks.
    - d) Child attempts to do task as instructed even if task is difficult.
  9. Shows pleasure in accomplishment and active task mastery
    - a) Child makes negative comment or negative expression when completing task.
    - b) Child is neutral when getting task right.
    - c) Child appears slightly pleased in completing tasks.
    - d) Child appears happy after completing task. May show excited body movements (e.g., “alright!” clapping)
  10. Confident
    - a) Child shows hesitation or reluctance on easy items, gives up easily (e.g., “I can’t do this.”).
    - b) Less confident child shows repeated hesitation or asks questions that indicate a lack of confidence.
    - c) Child is diligent, straightforward in answering tester's questions.
    - d) Child shows confidence by comments such as “I know this one.” Child is eager, energetic.
  11. Defiant
    - a) Child actively, directly refuses to comply with tester's request or direction.
    - b) Child tests limits but responds to tester's prompt or restatement or request.
    - c) Child says “no,” but then follows tester's initial request. Tester does not have to “say it again.”
    - d) Child never exhibits active defiance.
  12. Passively noncompliant
    - a) Child appears not to hear instruction, even when tester repeats request.
    - b) Child ignores tester but responds to prompt when tester repeats request/directive.
    - c) Child seems slow to comply. Tester does not restate request, but wonders if child heard.
    - d) Child hears requests and responds appropriately.
  13. Modulates and regulates arousal level in self.
    - a) Child becomes over-aroused and has difficulty regaining self-control.
    - b) Child becomes over-aroused (sad, frustrated, and silly) and needs prompt from tester but is able to calm down.
    - c) Child becomes briefly over-aroused (sad, frustrated, silly) but quickly calms

- without help from adult tester.
- d) Child highly regulated. Never becomes sad, frustrated, or silly.

## **RAPID AUTOMATIC NAMING TEST**

Materials: RAN stimulus sheet, timer

### **Example:**

*Ona pa zithunzi-tunzi pa pepala iyi. Unene zithunzi-tunzi izi mu m'ndandanda uwu:*  
(pointing from top to bottom as indicated by the arrow; just do the first two as examples).

### **Test Instructions:**

*Tsopano ndifuna kuti unene zithunzi-tunzi izi mwamusanga, cifukwa ndidzayamba kuona nthawi. Wakonzeka?*

RN1	Total time in seconds	# _____ <b>seconds</b>
RN2	Number of skipped words	
RN3	Self-corrections	
RN4	Number of mistakes (skipped words not self-corrected)	



## STROOP- LIKE (OPPOSITES) TEST

**Materials:** Tablet with slides the following drawings as shown below in Fig 1. Display the Stroop-like slides to the child at a position that is comfortable for the child.

### Administration instructions

Say, “(name of the child) I am going to show you two people, a fat one (Fig.1a) and a slim one (Fig.1b), an elephant (Fig.1c) and a mouse (Fig.1d), a girl (Fig.1e) and a boy (Fig. 1f), I want you to tell me the opposite of what you are going to see. When you see a fat person (clown) you are supposed to say slim and when you see a slim person you are supposed to say fat. You are supposed to say "big" when you see a mouse and "small" when you see an elephant. Say "boy" when you see a girl and say "girl" when you see a "boy". Can you do that? Let us try (demonstrate) what does this picture show?”

Allow the child to practice the examples of the **fat/slim condition, small/big condition and the boy/girl condition** until the child understands to say the opposite colour of the dog that they see on the screen.

When the child understands that instructions then begin the test by saying “okay, do you have any questions? Ready?”

### Scoring instructions:

Record the completion test time and look out for **self-corrections** and **incorrect** responses during the test.

Number of test items	
Number of correct responses	
Number of self- corrections	
Number of incorrect responses	
Completion time (seconds)	

**Figure 12**

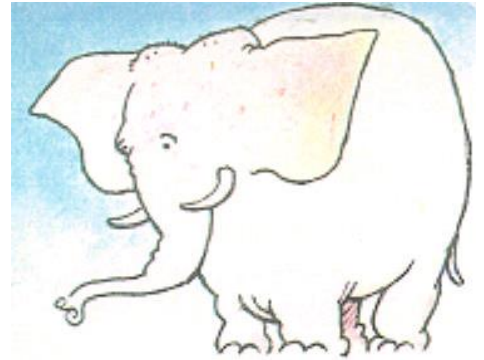
*Stimulus for the Child friendly Stroop test*



Fat clown (Fig.10a)



Slim clown (Fig.10b)



Elephant (Fig.10c)



Mouse (Fig.10d)



Girl (Fig. 10e)



Boy (Fig.10f)

## DIGIT SPAN TEST- FORWARD VERSION

**Say, I am going to say some numbers. Listen carefully, I can only say them once. When I stop, you say them back to me in the same order. Just say what I say. Are you ready?**

Proceed to item 1 and score by circling either **1** for correct and **0** for incorrect recall of digits.

Item	Trial	Correct responses	Score
1.	2-9		1 0
	5-4		1 0
2.	3-9-6		1 0
	6-5-2		1 0
3.	5-4-1-7		1 0
	9-1-6-8		1 0
4.	8-2-1-9-6		1 0
	7-2-3-4-9		1 0
5.	5-7-3-6-4-8		1 0
	3-8-4-1-7-5		1 0
6.	2-1-8-9-4-3-7		1 0
	7-8-5-2-1-6-3		1 0
7.	1-8-4-2-7-5-3-6		1 0
	2-7-9-6-3-1-4-8		1 0
8.	7-2-6-1-9-4-8-3-5		1 0
	4-3-8-9-1-7-5-6-2		1 0
9.	6-2-5-3-1-9-8-5-4-7		1 0
	9-4-3-8-7-5-2-9-6-1		1 0

## PENCIL TAPPING TEST

**Materials:** two pencils and a scoring sheet

Give one pencil to the child, and keep one pencil for yourself.

Say, **“We are going to play a new game now. When I tap my pencil on the table once (demonstrate), I want you to tap your pencil twice. Can you do that?”**

Allow the child to practice until the child taps correctly.

**“When I tap my pencil on the table twice (demonstrate), I want you to tap your pencil once. Can you do that?”**

Allow the child to practice until the child taps correctly.

**“When I tap my pencil on the table 3 times (demonstrate), do not tap your pencil at all. Now let us try it.”**

Tap once, then twice, then 3 times, then repeat. Allow the child to practice until the child is able to tap 3 sequences in a row correctly.

Say, **“Great, now we are ready to play the game. When I tap once, I want you to tap 2 times. When I tap 2 times, I want you to tap once. When I tap 3 times, do not tap at all. Are you ready?”** if the child is ready, begin the test.

Score sheet

Assessor taps	Child taps	Score	Assessor taps	Child taps	Score
1			1		
2			2		
2			1		
2			2		
1			3		
1			1		
1			1		
3			2		
2			2		
1			1		
2			3		
3			1		
1			1		
1			1		
2			3		
1			2		
2			1		
2			1		
2			1		
1			3		
<b>Total errors</b>			<b>Total score (40 minus the total errors):</b>		

## Appendix 6: Phonological Awareness Tests

### CHINYANJA RHYME RECOGNITION TEST

Materials: Nyanja Rhyme Recognition test sheet

#### Instructions

*Say; Ndidzakupasa mau, yena yali ndi **kamvekelo** kolingana kulast kwake. Koma yena mau yali ndi **kamvekelo** kosiyana ku last kwake.*

#### Example 1

##### **Njira ndi Alira**

*Mau awa amveka kupalana ku last kwake. Yonse yali ndi **kamvekelo** ka ‘**ra**’ ku kulast kwake.*

##### **Nkunda ndi Anthu**

*Mau awa amveka mosiyana kulast kwake. Ina ili ndi **kamvekelo** ka ‘**nda**’ ku kulast kwake, ina ili ndi **kamvekelo** ka ‘**thu**’ ku kulast kwake.*

*Lomba pano ndi zakamba mau awiri, ndifuna uniwuze ngati yalingana **kamvekelo** kulast kwake kapena yasiyana **kamvekelo** kulast kwake.*

#### Example 2

##### **Mtima ndi Nsima**

*Kodi mau awa amveka kupalana kapena kusiyana **kamvekelo** kulast kwake?*

*If the child gets example 2 correct say; eye **Mtima ndi Nsima**..... aya mau amveka kupalana kulast kwake. Yonse yali ndi **kamvekelo** ka ‘**ma**’ ku kulast kwake.*

*If the child fails, correct the child and proceed to example 3.*

#### Example 3

##### **Famu ndi Juzi**

*Kodi mau awa amveka kupalana kapena mosiyana **kamvekelo** kulast kwake?*

*If the child gets example 3 correct say; eye **famu ndi juzi**..... aya mau amveka mosiyana kulast kwake. Proceed to the test.*

*If the child fails example 3, correct the child and reteach example 1, then proceed to the test.*

#### Test Instructions

*Say; Lomba ndidzakupasa mau ndipo ndifuna kuti undiuzze ngati yamveka kupalana kapena mosiyana **kamvekelo** kulast kwake.*

For each of the pairs add these words;

**(Mention the two target words)** and ask, *Kodi mau awa amveka kupalana kapena mosiyana **kamvekelo** kulast kwake?*

<b>S/N</b>	<b>Words</b>		<b>Incorrect(√)</b>	<b>Correct(√)</b>
1	Poto	Moto		
2	Peni	Zuba		
3	Loko	Pika		
4	Kapokola	Nkoloko		
5	Delesi	Basi		
6	Chola	Nshaba		
7	Ndevu	Njovu		
8	Myala	Chipyango		
9	Mpando	Nyumba		
10	Galu	Fulu		
11	Samba	Lemba		
12	Nyundo	Khala		
13	Belenga	Pyanga		
14	Mtengo	Bola		
15	Lima	Tema		
16	Mbuzi	Buluzi		
17	Vala	Nkumba		
18	Kendulo	Botolo		
19	Sukulu	Peluka		
20	Jumpa	Kwempa		

## CHINYANJA RHYME PRODUCTION TEST

Materials; test template/score sheet and pencil

Say; *Ndidzakamba mau ndipo ndifuna kuti undiuze liu limene lipalana nalo **kamvekelo** ku last kwake. Tiye tiyeseke.*

### Example 1

***Basi na Delesi**; Mau aya yapalana **kamvekelo** kulast kwake. Yonse yali ndi **kamvekelo** ka 'si' kulast kwake.*

Ask the Child; *Ndiuze liu lina limeme lipalana **kamvekelo** kulast kwake ndi **Basi**.*

If the child gets example 1 correct say;

*eye **basi na** ..... (any word child produces ending in **si**) aya mau yapalana **kamvekelo** kulast kwake. Yonse yali ndi **kamvekelo** ka 'si' kulast kwake.*

If the child fails to produce a rhyming word say;

*wayesako liu lina lamene lipalana **kamvekelo** kulast kwake ndi **basi ni Sutukesi**. Aya mau **basi-sutukesi** yapalana **kamvekelo** kulast kwake. Yonse yali ndi **kamvekelo** ka 'si' kulast kwake.*

### Example 2

Say; *Ndiuze liu lina limeme lipalana **kamvekelo** kulast kwake ndi **nyumba**.*

If child fails to produce a rhyming word use *Nyumba-Nsomba* to teach them.

Say; *Wayesako. Liu lamene lipalana **kamvekelo** kulast kwake ndi **nyumba, ni nsomba**.*

*Aya mau **Nyumba-Nsomba** yapalana **kamvekelo** kulast kwake. Yonse yali ndi **kamvekelo** ka 'mba' kulast kwake.*

**If child does not produce a rhyming word in both examples, then proceed to the test.**

S/N	Words	Child's Response	Correct (√)	Incorrect (√)
1	<b>Gona</b>			
2	<b>Supuni</b>			
3	<b>Mbuzi</b>			
4	<b>Lima</b>			
5	<b>Lemba</b>			
6	<b>Zitatu</b>			
7	<b>Chimanga</b>			
8	<b>Mutolilo</b>			
9	<b>Mbululuka</b>			
10	<b>Moto</b>			
11	<b>Culu</b>			
12	<b>Sopo</b>			
13	<b>Coko</b>			
14	<b>N'gombe</b>			
15	<b>Kakowa</b>			
16	<b>Sisi</b>			

17	<b>Dzinja</b>			
18	<b>Kapokola</b>			
19	<b>Mbale</b>			
20	<b>Windo</b>			

### CHINYANJA PICTURE RHYMING TEST

**Say;** *Ndidzakuonesa zithunzi-tunzi zosiyana siyana. Ndifuna uniwuze zili pa zithunzi-tunzi izi. (Turn to Sample picture 1)*

#### Example 1

**Say;** *Kodi waziona zithunzi-tunzi izi? Point to sample picture 1.*

*Sewenzetsa mau amodzi ndiuze cabe zimene ukuonapo. (Expected responses; N'gombe, Matepo, Chimanga, Sopo).*

**NB: If the child does not successfully name the four items tell the child the names of the items.**

If the child successfully names the four items, say to the child;  
*wacita bwino. Ndi zasonta ndikukamba maina awiri ya zithunzi-tunzi yali ndi kamvekelo kopalana kulast kwake.*

**Say; Sopo, Matepo (pointing at items)**

*Maina awa yapalana kamvekelo kulast kwake. Yonse yali ndi kamvekelo ka 'po' kulast kwake.*

**Say; Lomba ndidzakulangiza zithunzi-tunzi zina. Go to picture sample 2.**

#### Example 2

**Say;** *Kodi waziona zithunzi-tunzi izi? Point to sample picture 2.*

*Sewenzetsa liu limodzi ndiuze cabe zimene ukuonapo. (Expected responses; Njinga, Bola, Minga, Shati.)*

**NB: If the child does not successfully name the four items tell the child the names of the items.**

If the child successfully names the four items, say to the child;  
*wacita bwino.*

**Ask the Child:** *Ndi zithunzi-tunzi ziti zimene zipalana kamvekelo kulast kwake. (Expected responses; Minga, Njinga)*

**If the child does not get the concept of the test, correct the child and move to example 3.**

**Assessor say; Lomba ndidzakulangisa zithunzi-tunzi zina. Go to sample picture 3.**

#### Example 3

**Say;** *Kodi waziona zithunzi-tunzi izi? Point to sample picture 3.*

These are verbs say; *Sewenzetsa liu limodzi ndiuze zinthu zomwe anthu awa alikucita.*  
(Expected responses; **Phempera, Tilira, Tyola, Yimba**)

**NB: If the child does not successfully name the four actions tell the child the actions.**

If the child successfully names the four actions, say to the child; *wacita bwino.*

**Ask the Child:**

*Ndi zithunzi thunzi ziti zimene zipalana kamvekedwe kulast kwake.* (Expected responses; **Pempera, Tilira**)

**If the child does not get the concept of the test, correct the child and go through example 1 again. Then proceed to the test.**

### Test Instructions

**Says;** *kodi waziona zithunzi-tunzi izi apa? Kusewenzetsa liu limodzi ndiuzeko zinthu kapena zocitika zamene ulikuona.*

After the child has successfully named the items, ask the child; *Kodi ndi zithunzi-tunzi ziti zimene zipalana kamvekelo kulast kwake?*

**NB: Incorrect response: if the child does not successfully name the four pictures of either the nouns or verbs, tell the child the names. If the child does not get the rhyming words correct, move to the next item.**

### Scoring Sheet

S/N	Child's Response	Incorrect (√)	Correct (√)
E1	N'gombe <b>Matepo</b> Cimanga <b>Sopo</b>		
E2	<b>Njinga</b> Bola <b>Minga</b> <b>Shati</b>		
E3	<b>Phempera</b> <b>alira</b> Tyola      Yimba		
1	Windo <b>Moto</b> Bedi <b>Poto</b>		
2	<b>Loko</b> Nsapato      Chona <b>Nkoloko</b>		
3	<b>Nyundo</b> Tebulo      Foni <b>Mpando</b>		
4	<b>Myala</b> Kamwibili      Tapu <b>Chola</b>		
5	<b>Galu</b> Kapokola      Kwanja <b>Fulu</b>		
6	Wailesi      Mbalame <b>Mtengo</b> <b>Chipyango</b>		
7	<b>Delesi</b> Mugomo      Nkuku <b>Basi</b>		
8	<b>Supuni</b> Buku <b>Peni</b> Maso		
9	<b>Ndevu</b> Nsimbi      Koswe <b>Njobvu</b>		
10	<b>Lima</b> Cheka      Sakula <b>Tema</b>		
11	<b>Jumpa</b> Gwada      Kumwa <b>Kwempa</b>		
12	<b>Belenga</b> Gona      Tyola <b>Pyanga</b>		

13	<b>Phika</b>	Taya	Gela	<b>Peluka</b>		
14	Gulugufe	<b>Mbuzi</b>	Bhaka	<b>Buluzi</b>		
15	Nshawa	<b>Mbale</b>	Nkonono	<b>Cule</b>		
16	<b>Nyumba</b>	Motoka	Muthu	<b>Nkumba</b>		
17	Cithunzi	Ntochi	<b>Kendulo</b>	<b>Botolo</b>		
18	Capa	<b>Nkala</b>	Kudya	<b>Vala</b>		
19	<b>Samba</b>	Donsa	Posha	<b>Lemba</b>		
20	<b>Siketi</b>	Kapu	Nsomba	<b>Basiketi</b>		

## Appendix 7: Informed Consent and Participant Information sheet

**THE UNIVERSITY OF ZAMBIA**  
**DIRECTORATE OF RESEARCH AND GRADUATE STUDIES**  
**HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE**

Telephone: +260-211-290258/293937  
32379

P O Box

Fax: +260-211-290258/293937

Lusaka, Zambia

E-mail drgs@unza.zm

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***Informed Assent for Children***

This informed assent form is for children aged 6 years who attend early childhood education in Kafue, Chilanga and Lusaka districts who we are inviting to participate in the study aimed at understanding how local language animated stories and rhymes presented on tablet computers improve preschool children's initial literacy skills.

Name of Principle Investigator: Dr.B.Matafwali

Name of Organization: University of Zambia

Name of Sponsor: Lolle Nauta Foundation

This Informed Assent Form has two parts:

- Information Sheet (gives you information about the study)
- Certificate of Assent (this is where you sign if you agree to participate)

You will be given a copy of the full Informed Assent Form

### **Part I: Information Sheet**

#### **Introduction**

My name is \_\_\_\_\_ and my job is to find out how local language animated stories and rhymes presented on tablet computers improve preschool children's initial literacy skills. We want to know if these newly developed materials will help children to know how to read in the local language. We think this research could help tell us to do that.

I am going to give you information and invite you to be part of a research study. You can choose whether or not you want to participate. We have discussed this research with your parent(s)/guardian and they know that we are also asking you for your agreement. If you are going to participate in the research, your parent(s)/guardian also have to agree by signing some forms. But if you do not wish to take part in the research, you do not have to, even if your parents have agreed.

You may discuss anything in this form with your parents or friends or anyone else you feel comfortable talking to. You can decide whether to participate or not after you have talked it over. You do not have to decide immediately.

There may be some words you don't understand or things that you want me to explain more about because you are interested or concerned. Please ask me to stop at any time and I will take time to explain).

**Purpose: Why are you doing this research?**

We want to find better ways of teaching children how to read in the local language. We have animated stories and rhymes which help young children learn how to read in the local language which we are hoping might be better than the materials that are currently being used. In order to find out if these materials are better we have to test them.

**Choice of participants: Why are we asking you?**

We are testing this animated stories and rhymes on children who are your age – 6 years old - who live in either in Lusaka, Chilanga or Kafue. We are only testing the stories and rhymes on children who are in preschool.

**Participation is voluntary: Do you have to do this?**

You don't have to be in this research if you don't want to be. It's up to you. If you decide not to be in the research, it is okay and nothing changes. This is still your school, everything stays the same as before. Even if you say "yes" now, you can change your mind later and it's still okay.

If applicable: If anything changes and we want you to stay in the research study even if you want to stop, we will talk to you first).

If you decide not to take part in this research study, do you know what your options are? Do you know that you do not have to take part in this research study, if you do not wish to? Do you have any questions?

**Procedures: What is going to happen to you?**

If you decide to take part in this research the following will happen

1. You will first be tested (pre-test) on two occasions.
2. You will then be given tablets to play 3 times a week for 8 weeks.
3. You will be tested again at the end of the 8 weeks (post-test)
4. When you move to Grade One, you will be tested again at the beginning of term two.

**Risks: Is this bad or dangerous for you? Benefits: Is there anything good that happens to you?**

There is no known risk associated with participation in this research study. The benefits of the study include the following:

- a) Increased knowledge on the effects of multimedia on preschool children's literacy acquisition.
- b) Identification of preschool children at high risk of developing learning disabilities.
- c) Increased awareness of the influence to technology enhanced literacy tools on language development.

Can you tell me if you have understood correctly the benefits that you will have if you take part in the study?

**Reimbursements: Will you get anything for being in the research?**

Because you live quite far from the school, we will give your parents enough money to pay for transport here and (whatever other expense is reasonable). Do you know if the study will pay for your travel costs, and do you know how much you will be reimbursed? Do you have any other questions?

**Confidentiality: Is everybody going to know about this?**

We will not tell other people that you are in this research and we won't share information about you to anyone who does not work in the research study. After the research is over, you and your parents will be told of the results.

Information about you that will be collected from the research will be put away and no-one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key. It will not be shared with or given away.

Did you understand the procedures that we will be using to make sure that any information that we as researchers collect about you will remain confidential? Do you have any questions about them?

**Compensation: What happens if I get hurt?**

If you become sick during the research, we will look after you. We have given your parents information about what to do if you are hurt or get sick during the research

**Sharing the Findings: Will you tell me the results?**

When we are finished the research, I will sit down with you and your parent and I will tell you about what we learnt. I will also give you a paper with the results written down. Afterwards, we will be telling more people, scientists and others, about the research and what we found. We will do this by writing and sharing reports and by going to meetings with people who are interested in the work we do.

**Right to Refuse or Withdraw: Can I choose not to be in the research? Can I change my mind?**

You do not have to be in this research. No one will be mad or disappointed with you if you say no. It's your choice. You can think about it and tell us later if you want. You can say "yes" now and change your mind later and it will still be okay.

**Who to Contact: Who can I talk to or ask questions to?**

You can ask me questions now or later. You can ask the assessor questions. I have written a number and address where you can reach us or, if you are nearby, you can come and see us. If you want to talk to someone else that you know like your teacher or class mate that's okay too.)

If you choose to be part of this research I will also give you a copy of this paper to keep for yourself. You can ask your parents to look after it if you want.

You can ask me any more questions about any part of the research study, if you wish to. Do you have any questions?

**PART 2: Certificate of Assent**

I understand the research is about testing a new vaccine for malaria and that I might get either the new vaccine which is being tested or the vaccine which is currently being used. I understand that I will get an injection and that I will come for regular monthly check-ups at the clinic where I will give a blood sample with a finger prick.)

**I have read this information (or had the information read to me) I have had my questions answered and know that I can ask questions later if I have them.**

**I agree to take part in the research.**

*OR*

**I do not wish to take part in the research and I have not signed the assent below. \_\_\_\_\_ (initialled by child/minor)**

**Only if child assents:**

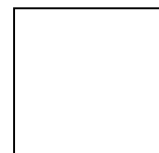
**Print name of child \_\_\_\_\_**

**Signature of child: \_\_\_\_\_ Date: \_\_\_ / \_\_\_ /2018**

**I have witnessed the accurate reading of the assent form to the child, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.**

***Print name of witness (not a parent) \_\_\_\_\_ AND Thumb print of participant***

***Signature of witness \_\_\_\_\_***



Date: \_\_\_ / \_\_\_ /2018

I have accurately read or witnessed the accurate reading of the assent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given assent freely.

Print name of researcher \_\_\_\_\_

Signature of researcher \_\_\_\_\_

Date: \_\_\_ / \_\_\_ /2018

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the child understands what will be involved in the study.

I confirm that the child was given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this assent form has been provided to the participant.

Print Name of Researcher/person taking the assent \_\_\_\_\_

Signature of Researcher /person taking the assent \_\_\_\_\_

Date: \_\_\_ / \_\_\_ /2018

Copy provided to the participant \_\_\_\_\_ (initialled by researcher/assistant)

Parent/Guardian has signed an informed consent \_\_\_Yes \_\_\_No \_\_\_\_\_ (initialled by researcher/assistant)



HSSREC FORM 1a  
**THE UNIVERSITY OF ZAMBIA**  
**DIRECTORATE OF RESEARCH AND GRADUATE STUDIES**  
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**HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE**

**PARTICIPANT INFORMATION SHEET**

**TITLE OF RESEARCH:**

Effects of Stories, Songs, and Rhymes presented through electronic media on Language and Literacy Skills among Preschool and First Grade learners in Zambia

**PURPOSE OF THE STUDY:**

The purpose of the study is to better understand how local language animated stories and rhymes presented on tablet computers improve preschool children's initial literacy skills that have spent less than a year in school. The study will also examine how exposure to technology-enhanced literacy tools in preschool years influence the acquisition of later literacy skills in Grade One.

**DESCRIPTION OF THE STUDY AND YOUR INVOLVEMENT:**

This research study will use a pretest-posttest experimental method. Three hundred and sixty (360) six (6) year old pre-school children will be randomly selected from 12 pre-schools. Thirty (30) children per school will be randomly selected and divided into three groups of ten (10) and assigned to the following conditions: exposure to animated stories and rhymes on a tablet computer, exposure to non-literary animated games on a tablet and the last group will not be exposed to any tablet computer. All the children will be tested before the study (pre-test) and after the intervention (post-test) to determine what they will learn from the intervention material. The same children will be tested at the start and at the end of grade 1 to assess whether exposure to animated rhymes and stories through tablet computers in preschool enhances their ability to read in first grade. The intervention will take 24 sessions over a period of 6 weeks. Preschool

children will be exposed to 3 sessions per week and each session will last 15 minutes. All interventions will take place within the school. The researchers, the research assistants and teachers will monitor the exposure time and children's engagement with the tablet computer.

### **CONFIDENTIALITY:**

All efforts will be made to keep the participant's personal information confidential. All identifiable information will be stored in a secure facility with restricted access to only researchers. All information collected is guaranteed to be used for research purposes only.

### **VOLUNTARY PARTICIPATION AND WITHDRAWAL:**

The participants are assured that participation in this research study is voluntary. The participant is free to withdraw from the study at any time. Any information that will help the participant to make an informed decision whether or not to participate in the study will be willingly availed to the participant by the principal investigator.

### **RISKS AND BENEFITS:**

There are no known risks associated with participation in this research study. The benefits of the study include the following:

- a. Increased knowledge of the effects of multimedia on preschool children's literacy acquisition.
- b. Identification of preschool children at high risk of developing learning disabilities.
- c. Increased awareness of the influence of technology-enhanced literacy tools on language development.

### **CONTACTS FOR QUESTIONS (Names, addresses and phone numbers of the following):**

#### **Principal Investigators**

Prof. Beatrice Matafwali

Prof. Adriana Bus

Prof. Sophie Kasonde-N'gandu

Dr. Tamara Chansa- Kabali

Dr. Sylvia Mwanza-Kabaghe

Mr. Gabriel Walubita

Mrs. Mubanga Mofu-Mwansa

Mrs. Janet Serenje Chipindi

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