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MASTERY MOTIVATION AND EXECUTIVE FUNCTIONS AS SCHOOL READINESS FACTORS: ENHANCEMENT OF SCHOOL READINESS IN KENYA

PhD Dissertation

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ABBREVIATIONS

AMOS	Analysis of Moment Structures
ATL	Approaches to Learning
AVE	Average Variance Extracted
BRIEF	Behavioral Rating Inventory of Executive Functions
CBC	Competency-Based Curriculum
CHEXI	Childhood Executive Functioning Inventory
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CI	Confidence Interval
CR	Composite Reliability
DBR	Design-Based Research
DMQ 18	Dimensions of Motivation Questionnaire 18
ECD	Evidence Centred Design
EDR	Education Design Research
EF	Executive Functions
EFA	Exploratory Factor Analysis
GBA	Game-Based Assessment
FOCUS	Finding out Children's Unique Strength App
KMO	Kaizer-Meyer-Olkin
LMICs	Low and Middle Income Countries
MELQO	Monitoring Early Learning, Quality and Outcomes
RMSEA	Root-Mean-Square Error of Approximation
SD	Standard Deviation
SES	Socioeconomic Status
SPSS	Statistical Package for Social Sciences
SRL	Self-Regulated Learning
SRMR	Standardised Root Mean Square Residual
TLI	Tucker-Lewis Index
UNICEF	United Nations Children's Fund

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CHAPTER 1
INTRODUCTION

1.1 Context of the Study

There is a consensus among researchers that high-quality Early Childhood Education contributes immensely to brain development, future academic success, health outcomes and overall national economic growth (Black et al., 2017; UNICEF, 2012). Additionally, the first years of life contribute immensely to social, language and cognitive skills as well as approaches to learning (Shonkoff, 2016). Existing evidence also suggests a strong correlation between the development of a country and the extent of growth of its Early Childhood Education sector (Józsa et al., 2018). Moreover, the World's Sustainable Development Goal 4 aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Specifically, agenda 4.2 focuses on quality early childhood development and education so that children can progress to primary school successfully and achieve societal equity (United Nations, 2015). Similar initiatives are also covered by the agenda 2063, 'The Africa we want' aspiration 1.14, requiring all states to expand universal access to quality Early Childhood Education in Africa (African Union, 2015). However, only 18 per cent of children from low-income countries and 50 per cent from Low and Middle-Income Countries (LMIC) can access Early Childhood Education, the majority of whom are wealthy and live in urban centres (UNICEF, 2015). Moreover, approximately 61% of children from developing countries are still out of school (UNESCO, 2016). For this reason, any strategy to increase access to quality education and reliable measuring of progress in learning and child development in and out of school has received global attention more than ever before (Barrett et al., 2015; Pisani et al., 2018).

Studies have established that school readiness predicts both school and life success; therefore, its precise assessment and enhancement are critical (Barrett et al., 2017; Russo et al., 2019). Children who start school without school readiness skills such as emerging literacy, numeracy, approaches to learning and socioemotional competence have challenges catching up with peers who have higher levels of such skills (Burchinal et al., 2015; Duncan et al., 2015; Fitzpatrick et al., 2014; Józsa, 2016; Russo et al., 2019) leading to a "Mathew effect". A situation where participants with an initial advantage continue to perform better even in the future while those with an initial disadvantage perform poorly. This effect continues to open the gap between those who have more,

e.g.,children who are ready to learn and the disadvantaged, in this case, children who are not ready to learn (e.g.,Pfost et al., 2014). This evidence suggests that attending a quality early childhood programme could be a solution to ending intergenerational poverty, especially for children coming from poor backgrounds (Arnold et al., 2007; Razza et al., 2015). Therefore, reducing the number of children with early learning difficulties before joining school contributes to decreasing school dropouts and improving school and life success (Pisani et al., 2018).

School readiness can also increase societal benefits such as promoting the universal right of all individuals to an education, greater social justice and social cohesion, better efficiency of education systems, better health outcomes, poverty reduction and higher growth rates (UNICEF, 2012). Therefore, any possible intervention brought early in life will yield better educational outcomes (Bers, 2019; Ghosh, 2019). Furthermore, econometric evidence suggests that return on investment is high if skill development intervention is strategically implemented at an early age compared to the adolescent stage, especially for children from disadvantaged backgrounds (Heckman & Mosso 2014). Other studies have indicated that personal and social problems such as school dropout, unemployment, welfare dependence, criminal behaviour, and poverty are substantially lower over a 10-25 year period for students who attended quality preschool than those who did not (Burchinal, 2015). For this reason, countries like the USA have emphasised ensuring that school readiness domains, especially Approaches to Learning, are assessed and enhanced (Józsa & Barrett, 2018).

Historically, several programmes have attempted to address the challenge of school readiness in Kenya. They include the National Centre for Early Childhood Education (NACECE) under the support of the Bernard Leer Foundation in 1994 (Kenya Institute of Education, 2006), the Kenya Early Childhood Project, 1997-2004, the Rapid School Readiness Initiative and Madrasa Resource Centre programme (Kenya Institute of Education, 2007). Furthermore, in 2016, the Research Triangle International (RTI) and African Population and Health Research Center (APHRC) introduced the Tayari (readiness) programme in three Counties in Kenya. The Tayari scalable model is the only one that had specific strategies to improve both academic and character traits or non-academic skills such as executive functions (Piper et al., 2018); all the others had more emphasis on access to schools and academic skills. To ensure holistic learning, development of children and enhancement of school readiness, several legal documents have also been tabled, including the Constitution of Kenya revised in

2010, the Basic Education Act of 2013, National Preprimary Education Policy (Republic of Kenya, 2017) and Preprimary Education Policy Guidelines (Republic of Kenya, 2018). To capture the aspirations of these documents and other educational stakeholders, Kenya introduced a new Curriculum, the Competency-Based Curriculum(Republic of Kenya, 2017).

Given the Kenya Government's significance to the growth of Early Childhood Education in the National Education Sector Plan (2013–2018), it launched the National Pre-primary Education Policy. The Policy identified three significant challenges. First, there is no smooth transition from pre-primary to grade one due to too much emphasis on academic and cognitive skills during school readiness assessment and disharmony between the two environments. Second, there is too much emphasis on numeracy and literacy geared toward primary school success which does not conform to the needs of 4-5-year-olds (Republic of Kenya, 2019). Third, there has been an inadequate balance of summative and formative assessment of learning outcomes at the pre-primary education level (Republic of Kenya, 2017b). As an intervention to this poor quality service delivery, the Ministry of Education launched the Kenya School Readiness Assessment Tool and formative assessments (Republic of Kenya, 2017b). However, Kenya School Readiness Assessment Test, for example, does not capture motivation (non-cognitive), executive functions (non-academic general cognitive skill) domains, nor Approaches to Learning. Therefore, it is not truly possible to implement interventions to assist children with low academic performance during the transition to grade 1.

1.2 Statement of the Problem

One of the domains of school readiness that is rarely fully assessed is approaches to learning (Józsa et al., 2017; Kagan et al., 1995; O'Farrelly et al., 2020). Approaches to Learning are attributes that help children learn: enthusiasm, self-regulation, persistence, motivation, interest, flexibility, initiative, reflection, attentiveness, cooperation, and independence (e.g., Hyson 2008; Kagan et al., 1995; Li et al., 2019; McDermott et al., 2012; Sabol and Pianta, 2017). These attributes are very similar to definitions of mastery motivation and executive functions in early childhood literature. Recently researchers have identified Mastery Motivation and executive functions as crucial components of Approaches to Learning (e.g.,Barrett et al., 2017; Buek, 2019; Duncan et al., 2018; Józsa & Barrett, 2018). Other literature surveys on Approaches to

Learning (e.g., Snow & Van Hemel, 2008) have also reported that this area is still under-researched and least understood. However, it is the most important since it is at the core of cognitive and socio-emotional interactions (Bustamante et al., 2016; Kagan et al., 1995; McWayne et al., 2004; Razza et al., 2015). For these reasons, it has attracted global attention (Zhang et al., 2021). In general, school readiness assessments emphasise cognitive factors that are phenotypically similar to academic performance, such as emergent literacy and numeracy, rather than Approaches to Learning and socioemotional school readiness (Li et al., 2019; Suleiman et al., 2016). However, Approaches to Learning, such as perseverance when faced with challenging tasks and the ability to hold problems in mind and solve them creatively, have been documented to be necessary for both the academic performance and socio-emotional development of children (Barrett et al., 2017; Bustamante et al., 2017; Hu et al., 2017; Hunter et al., 2018). Failure to assess motivation and executive functions presents a challenge because it is difficult to tell whether a child's performance is due to inadequate or high motivation or low or high executive functions. Lack of this vital information makes it difficult to provide individualised intervention (Willoughby et al., 2019) since executive functions or effective learning strategies account for up to 25% of the variance in successful outcomes (Hudson & McGoldrick, 2021).

Other scholars have also reported that personality and cognition interact in motivational contexts in one's environment, leading to acknowledging goals related to academic learning and performance (Demetriou et al., 2020). These Approaches to Learning skills are foundational for developing Critical Thinking, Creativity and Imagination, problem-solving, and Learning to Learn competencies, which are critical "soft skills" required for success in the 21st Century (Bers, 2017; Goldstein & McGoldrick, 2021; Sylva et al., 2016). In fact, this emphasis on external performance indicators such as scores and grades instead of focusing on trying hard, persisting and improving undermines motivation (e.g., Gottfried et al., 2013; Józsa et al., 2014).

The primary method of collecting information regarding school readiness in Early Childhood Education is primarily observation-based assessment and evaluation against guides on child development. To achieve these observation-based assessments, teachers spend hundreds of hours per year trying to fill these school readiness tests, the time that could be utilized in providing strategic skills to learners (US HHS, 2015). In addition, this assessment form requires thorough record-keeping and a low student-teacher ratio, a significant challenge in many Early Childhood Education centres

(Arnold et al., 2007, p. 22). These pressures on elementary and early childhood teachers have led to low job satisfaction, high teacher turnover, stress and burnout (Greenberg et al., 2016; Sandilos et al., 2019; Sparks, 2017). Additionally, most LMICs have relatively little access to trained examiners who can administer individual, direct assessments (Willoughby et al., 2019). Besides, preschool teachers cannot track and measure these non-cognitive skills, such as Approaches to Learning, due to the lack of accessible tools with strong psychometric properties and high predictive validity (Campbell et al., 2016). In practice, when Approaches to Learning is assessed at all, parent and/or teacher ratings are typically utilized, and it is unclear how such rating accurately reflects the child's abilities. However, the value of parent and teacher reports depends on the quality of information teachers and parents can produce. Characteristics of the teacher or parent, such as implicit bias or parental beliefs and practical difficulties, such as insufficient opportunity to carefully observe individual children in relevant contexts and memory error, are some of the challenges that reduce the validity of adult ratings as measures of the actual behaviour of the child (Józsa et al., 2014; Sasser et al., 2015). Furthermore, although adult ratings are available, they mostly confound competence and motivation (e.g., Józsa & Molnár, 2013; Józsa & Morgan, 2014; Józsa et al. 2014; Morgan et al., 2013).

Consequently, direct, child-administered methods have been suggested to compensate for these weaknesses. Ratings can be used to supplement direct assessments (Li, 2019). A form of direct assessment that could be administered without intensive training of examiners is a narrated, self-administered, computer tablet-based method. However, we are unaware of any tablet-based assessment of executive functions and mastery motivation used in Kenya to address this challenge. Therefore, the current study aims to develop a tablet-based assessment of executive functions and mastery motivation to support teachers and learners during school readiness assessments in the Kenyan context.

1.3 Purpose of the Study

School readiness sets the pace for all future education. On the other hand, poor school readiness is linked to later criminality, unemployment, and academic failure (Pelletier & Brent, 2002). Therefore, the availability of tools for proper assessment, intervention and support of children is critical. Although there are many tools for assessing children's learning and development, few are suitable for Low and Middle-

Income Countries (LMICs) since most of them were normed in high-income western countries (Pisani et al., 2018). The purpose of the present study is as follows: First, identify and develop a form of tablet-based direct assessment for school readiness that could be administered without the need for intensive training of examiners. Second, determine the suitability of the tablet-based assessment of school readiness for Kenya. Third, adapt Preschool Dimensions of Motivation Questionnaire 18 and the Childhood Executive Functioning Inventory to assess mastery motivation and executive functions in Kenyan context. Four, determine the association of executive functions and academic performance among Kenyan pupils in grade one. Four, assess the direct and indirect effect of mastery motivation and executive functions on academic performance of children during the transition to grade 1. Five, compare the predictive ability of mastery motivation for school readiness using tablet-based and when rated using Dimensions of Motivation Questionnaire 18.

1.4 Organization of the Dissertation

This dissertation is organized into seven chapters, including Introduction, Literature Review, Aims of the Research, Methodology, Development of Computer-Based Assessment of School Readiness, Empirical studies, Conclusion and Recommendations. Chapter 1 introduces the reader to the concept of school readiness and the study context. It further identifies the problem statement, purpose and significance of the study.

Chapter 2, the Literature Review, addresses the theoretical background of School Readiness, mastery motivation, executive functions, and their assessment procedures. The chapter also discusses the nexus between mastery motivation, executive functions and Approaches to Learning as one of the domains of school readiness. We also identified empirical studies in Approaches to learning, mastery motivation, executive functions and their relationship with academic performance and school readiness. Moreover, studies that suggest various intervention strategies are provided to show the malleability of the mastery motivation and executive functions. Finally, as a starting point for developing a tablet-based assessment of school readiness, the chapter discusses the theoretical foundations of game-based assessment of school readiness domains. The chapter concludes by identifying the gap in the literature and the contribution of this study in filling this gap. Part of this work contributed to a book chapter, “Implications of the DMQ for Education and Human Development: Culture,

Age and School Performance. In G. A. Morgan, H.-F. Liao, and K. Józsa (Eds.), *Assessing Mastery Motivation in Children Using the Dimensions of Mastery Questionnaire (DMQ)* (pp. 153–158). Szent István University, Gödöllő.

Chapter 3 focuses on the research aims in the form of research questions. A total of 5 studies and 20 research questions are highlighted. However, one study did not have research questions; instead, it developed five research hypotheses and later tested them in chapter 6.

Chapter 4 describes the methodology of the study. Since the study aimed to develop a tablet-based assessment of school readiness, the chapter introduces the Education Design Research (EDR) approach followed in this study. EDR, as a methodological framework, allows other scientific empirical studies and procedures to be applied to develop interventions to address educational challenges. Therefore, the study design, instruments, and procedures for developing the android tablet-based App are discussed within the EDR methodological framework.

Chapter 5 is dedicated to developing the tablet-based school readiness assessment to fit the Kenyan context. The chapter follows the Education Design Research Approach. As part of the problem analysis, a scoping review of the literature was done to identify the already existing game-based assessments of school readiness. This study was necessary to identify the existing gap and which App best fits the Kenyan context. After problem analysis, the chapter provides a step-by-step procedure to adapt and develop the App.

Chapter 6 presents four empirical studies that analysed the findings carried out from 2019 to 2021. Two empirical studies were conducted as pilot tests to validate and reflect on the app suitability in the Kenyan context. Several corrections were implemented, and retesting was done. The *Journal of New Approaches in Education Research* (Amukune et al., 2022a) accepted the scoping literature review and the *International Journal of Early Childhood* (Amukune et al.,2022b) accepted the adapted tablet based assessment of school readiness for Kenya for publication. To complement the tablet-based assessment, it was agreed that it is critical to assess mastery motivation and executive functions using ratings to fit the Kenyan context. The first study adapted the preschool DMQ 18 from English to Swahili. This study aimed to develop and validate the DMQ 18 in the Kenyan context to assess mastery motivation among English and Swahili speakers in Kenya. Part of this work contributed to writing two book chapters, "Evidence for Reliability of the DMQ" and "Best Practices in Translating and

Adapting DMQ 18 to Other Languages and Cultures", both In G. A. Morgan H.-F. Liao, and K. Józsa (Eds.), *Assessing Mastery Motivation in Children Using the Dimensions of Mastery Questionnaire (DMQ)* (pp. 87–104). Szent István University, Gödöllő. Part of this work was also accepted by the *Electronic Journal of Educational Research* (Amukune et al., 2021). The second empirical study investigated the psychometric studies of the Childhood Executive Functioning Inventory in Kenya and its association with educational performance in the Kenyan context. The *Journal of Psychological and Educational Research* (Amukune & Józsa, 2021) published the findings of this study. The third empirical study assessed the contribution of executive functions and mastery motivation to academic performance in Kenya. This study was crucial in helping the authors empirically determine the influence of executive functions and mastery motivation on academic performance. This study provided more evidence for study 4. After validating the DMQ 18 and the CHEXI in the Kenyan context, we used both the FOCUS app and the ratings to assess school readiness. We later compared the utility of the direct school readiness assessment using the FOCUS app and ratings. This work was also presented to two international conferences *European Association for Practioner Research on Improving Learning* (EAPRIL; Amukune & Józsa, 2021) and *European Early Childhood Research Association* (EECERA; Amukune & Józsa, 2021b).

Finally, the last chapter provides conclusions derived from the studies in the dissertation and possible recommendations for students, teachers, policymakers and researchers.

CHAPTER 2

LITERATURE REVIEW

This chapter comprises six subsections; the concept of school readiness, Approaches to Learning, Components of Approaches to Learning, mastery motivation, executive functions, Computer-based assessment of school readiness and Research gap. The first sub-section introduces the reader to "the concept of school readiness, its significance, assessment and domains. The theoretical framework of this study of Approaches to Learning then follows. The third and fourth sub-sections describe the components of approaches to learning; mastery motivation which is followed closely by the fourth subsection on Executive functions. These subsections discuss the relevance, assessment, intervention strategies, and relationship between mastery motivation and executive functions with academic performance. The fifth subsection provides the theoretical foundation for tablet-based school readiness assessment, another critical focus of this dissertation. Finally, the chapter concludes with a summary of the research gap identified in the literature review.

2.1 The Concept of School Readiness

It is agreed that children are born ready to learn (Kagan, 1999; Shonkoff & Philips, 2000), but researchers do not agree on what it means for children to be ready for school. Globally, there are over 150 definitions for school readiness (UNICEF, 2012). According to Meisels (1999), conceptions of school readiness centre around four framings of readiness construct: the nativist, empiricist, social constructionist and interactionist perspectives. The idealist/nativist frames the construct of readiness depending on the child. The child is ready for school when the level of development is appropriate—usually placed at a certain age, e.g. six years in Kenya (Republic of Kenya, 2018). This form of school readiness has been criticized since some learners could acquire that age but still have not mastered the prerequisite competencies. In the empiricist's view, the construct of readiness lies outside the child.

In this context, parents, teachers and school programmes provide knowledge, skills and experiences to prepare the child for school, and they determine when he/she will join the school. Despite the empiricist approach applied in many school systems, the approach is doomed to fail if the preparations are not child-centred. In the social constructivist framework, readiness is determined by the child's social setting. A child

could be ready in one family and not ready in another. Finally, the interactionist perspective frames readiness as a bi-direction between the child and the school. The school contributes in one direction, and the child from another direction. In this regard, school readiness is contributed by what teachers do with children and the knowledge, skills, and experiences that children bring with them. This approach is favoured because it balances the teachers and the child.

There are also other four approaches with a similar framing: "Maturational Approach", "Environmental Approach", "Social Constructivist Approach", and "Transactional Approach" (Kartal & Guner, 2018). The maturational approach entails the child acquiring the developmental age for school controlled by the child's biological processes, which are similar to the idealist approach. While in the Environmental approach, the child's readiness for school is determined by outside forces in the child's environment. In contrast, social constructivists evaluate school readiness based on the community's view, especially teachers' and parents' perceptions. Finally, the transactional approach views readiness based on the child's transaction and knowledge or learning from educational environments. These views have implications for policymakers. For example, if a country adopts an idealist/nativist (maturational approach) view of school readiness, it will have to decide the age it expects the child to be ready for school.

The modern conceptualisation of school readiness views it as a process contributed by different systems such as child peers, family, school and community readiness (Stein et al., 2019; UNICEF, 2012). According to UNICEF 2012, school readiness is addressed in three dimensions: the family's readiness, the school's readiness, and the child's readiness for school. While school readiness addresses in terms of curriculum, and physical and human resources of the centre where the child learns, child readiness for school, on the other hand, address developmental and biological processes that contribute to learning both at home and school.

Other authors have defined school readiness as the acquisition of competencies that will facilitate adjustment in school (e.g.,Hair et al., 2006). Others view school readiness as a multidimensional concept composed of cognitive (children's content knowledge), language (receptive and expressive), executive functioning, behavioural (sharing, cooperation, behavioural regulation), approaches to learning, socio-emotional, and health characteristics that provide children with the capability to adjust and succeed in school settings (Blair & Raver, 2015; Boivin & Bierman, 2013). Pianta and Sabol

(2017) also referred to this definition as a 21st-century definition of school readiness. This is the definition of school readiness adopted for this dissertation. The acquisition of these skills is vital to succeeding in school. These competencies were also identified earlier as school readiness domains by the National Education Goals Panel formed in 1991, which became the foundation for school readiness. In Kenya, school readiness refers to a "holistic measure of a child's ability to learn in primary school successfully" (Piper et al., 2018). The holistic measure is viewed based on the five domains identified by the National Education Goals Panel and Bierman and her colleague. School readiness in the Kenyan context is assessed using the Kenya School Readiness Test. However, as explained elsewhere in this dissertation the tool only assesses academic subjects alone.

2.1.1 Relationship Between School Readiness and Transition to School

School readiness and the transition to school are topical issues due to emerging evidence that a positive start to school influences successful educational and social experience, development and opportunities for later life (Barrett et al., 2017; Hugo et al., 2018; Russo et al., 2019). Moreover, school readiness and Transition to school are closely linked because children must be ready for school (Arnold et al., 2007). Thus, there are instances when the two are used interchangeably or viewed as closely connected (Dockett et al., 2014; Meisels, 1999). Some researchers also suggest readiness is a process (e.g.,Graue, 2006), while others argue it is an event and transition process (e.g.,Docket et al., 2014; O'Kane, 2007). According to UNICEF, 2012, school readiness has two main characteristics: (1) readiness of children, schools and families; (2) transition and gaining prerequisite competencies.

Transition is the period before, during, and after children move from a pre-school setting into primary school (Arnold et al., 2007). Other researchers have defined it as the time between the first visit to the new educational context and the final setting (Fabian & Dunlop, 2007; Kagan & Neuman, 1998). The way this transition is enhanced will make a difference to the learners in their early months and retention in the school system (Fabian & Dunlop, 2007). A wealth of research in transition studies, summarised by Dockett and Perry (2007), concluded that: children facing social and academic challenges in their early years are likely to experience problems in their school careers and adult life (Burchinal et al., 2015; Heckman & Mosso, 2014; Józsa, 2016). Therefore, different children also experience transition challenges differently (e.g.,Entwisle & Alexander 1993). However, if school and home experiences are

similar, the transition will be more comfortable (e.g.,Hanson et al., 2011; Rathbun et al., 2004). Despite the awareness of the significance of early childhood education impacts on academic performance and success in life, still, there is a dearth of research, programmes, policies and services for young children, especially in sub-Saharan African countries such as Kenya (Arnold et al., 2008; Black et al., 2017; Piper et al., 2018).

Due to the different range of developmental challenges that face the child and family during this transition period, no unified theory can explain these situations (Dockety et al., 2014). Consequently, other scholarly fields have provided complementary approaches that have helped explain the transition process. The most widely used in the study of transition is the ecological developmental model (Bronfenbrenner & Morris, 1998). This model has four interrelated levels: macro-, exo-, micro-, and mesosystem. Others that have been used include a model of transitions in the family (Fthenakis, 1998) and the results from research on stress, emotions and coping (Lazarus & Folkman, 1987). The socio-cultural theory is also significant in transition studies due to the interactional attribute of the child in the transition process (Babić, 2017). Other scholars have employed a cultural-historical theoretical perspective, especially from boundary work and crossing boundaries between preschool and school (e.g.,Edwards, 2010; Rantavuori, 2018). Time has always been a significant factor in transition research since it takes time; it influences child development, readiness, and age (Dockett et al., 2014). Researchers addressing this question have employed maturational theory (e.g.,Froumin 2018).

2.1.2 Assessment of School Readiness

Precise assessment of school readiness is critical (Barrett et al., 2017) because of the following reasons. First, at an early age, the assessment of child competencies is usually formative. Nevertheless, if correctly assessed, it can allow effective individualised intervention. Second, an accurate evaluation will provide parents and teachers with information to decide whether the child should delay school entry. Third, a reliable and meaningful school readiness assessment helps understand a particular programme or curriculum (Suleiman et al., 2016). Fourth, school readiness largely depends on the method of assessment used. Most school-readiness tests and reports are pencil and paper-based. These reports' value depends on the quality of information teachers, examiners, and parents can and do provide (Li et al., 2019).

The key characteristics of a good school readiness test are: (i) individual tests are better than group tests; (ii) test should be adaptive to reduce floor and ceiling effect; (iii) the test should be reliable and can be measured by retesting, equivalent form, and internal consistency (Sally et al., 2001).

Moreover, the assessment system should provide evidence in three domains: psychometric properties, appropriateness of the instrument in different cultures, languages, races and age groups, and domains intended as the focus of assessment (Snow & Van Hemel, 2008). Snow and her colleague emphasized the need to develop measures on Approaches to Learning and socioemotional domains since they are less researched than traditional subjects such as language and math. There are several internationally recognised school readiness tests. Najarian et al. (2018) and Rock & Stener (2005) reported the most commonly used school readiness tests as follows: (1) Peabody Picture Vocabulary Test-Revised (PPVT-R) ; (2) Wechsler Preschool and Primary Scale of Intelligence-Revised; (3) Stanford Binet intelligence scale fourth edition (SB-IV); (4) Woodcock-Johnson-Revised (WJ-R); (5)Achenbach system child behaviour checklist and (6) Early Childhood Longitudinal Study-Kindergarten Battery. Most school readiness assessment tools have focused on the cognitive domain, although there is enough evidence that other socio-emotional domains are essential in school readiness and preschool to school transition (Barrett et al., 2017; Blasco et al., 2014). Additionally, School readiness tools assess the pre-academic skills but do not include motivational and EF variables. This failure to include motivational and EF variables makes the school readiness kits unable to account for low performance due to little motivation or self-control difficulties (executive functions). As opposed to earlier definitions of school readiness that had prioritised pre-academic skills, notably emerging numeracy and literacy; currently, there is an emphasis on non-academic, behavioural aspects of school readiness such as approaches to learning (e.g.,Barrett et al., 2018; Hyson, 2008; McDermott et al., 2012; Meng, 2015) and socio-emotional skills (e.g.,Denham et al., 2014). Positive approaches to learning are vital since they can compensate for sub-optimal learning environments (Meng, 2015) and predict academic performance(Józsa & Barrett, 2018). This is because, at this critical age, the formation of intelligence, personality, social behaviour and physical development is at its peak (Clements & Sarama, 2019).

2.1.3 School Readiness Assessment Tools in Low and Middle-Income Countries

Although there are many tools for assessing children, few are suitable for LMIC since most of them were normed in high-income western countries; they are expensive and require skilled or trained examiners (Pisani et al., 2018). Some of the individualised clinical assessment tools for 0-6 years include the Ages and Stages Questionnaire(ASQ) and Bayley Scales of Infant, and Toddler Development charges up to $200 and $1000 per assessor, respectively (Fernald et al., 2009). Additionally, children's tools for 0-3 years are few or still in the development stage (Pisani et al., 2018). However, one tool exists for assessing the psychomotor development domain, specifically eye-hand coordination and locomotor skills for children below three years developed in Kilifi-Kenya, Kilifi Developmental Inventory (KDI; Kitsao-Wekulo et al., 2016). Finally, for over 3-year-olds, several tools are available that can be used to assess child evaluation programmes: the Early Childhood Development Index (ECDI; UNICEF, 2014); Early Development Index (EDI; Janus & Offord, 2007); The South African Early Learning Outcomes Measure (ELOM; Snelling et al., 2019), Regional Project on Child Development Indicators (PRIDI; Verdisco et al., 2014); Measuring Early Learning Quality and Outcomes (MELQO; UNESCO et al., 2017) and International Development and Early Learning Assessment (IDELA; Pisani et al., 2018) are the main ones. Table 1 contains the characteristics and focus of these tools.

Table 1

Characteristics of Some Major School Readiness Tests in the LMICs

School readiness test/child development tool	Age in years	Domain of Focus	Method	Level
Kilifi Developmental Inventory (Kitsao-Wekulo et al., 2016).	0-3	psychomotor development (eye-hand coordination and locomotor skills)	Rated/ Survey By caregiver	individualised
Early Childhood Development Index (ECDI), (UNICEF, 2014)	3-4	Literacy- numeracy; physical development; learning/cognition; and socioemotional development.	Rated/ Survey	Population/program based
Early Development Index (EDI; Janus & Offord, 2007)	3.5-6.5	Physical health and well-being; social competence; language and cognitive development; emotional maturity; and; communication skills and general knowledge.	Rated by teacher	Population-based
The South African Early Learning Outcomes Measure (ELOM; Snelling et al., 2019),	4-6	Emergent numeracy; gross motor development; fine motor; coordination and visual-motor integration; cognition; emergent	Rated/ Survey	Population-based

		literacy; mathematics; executive functioning; and language.		
Regional Project on Child Development Indicators (PRIDI; Verdisco et al., 2014)	2-5	Cognition, language and communication motor, socio-emotional	Rated	Population-based
East Asia-Pacific Early Child Development Scales in Asia (EAP-ECDS; Rao et al., 2014).	3-5	Cognitive, socio-emotional, language, motor, and emergent literacy approach to learning, Health, cultural knowledge hygiene and safety and participation	Direct assessment, direct measurement, parent interview by a trained examiner	Population
Measuring Early Learning Quality and Outcomes (MELQO) UNESCO et al., 2017	4-6	early mathematics skills and early literacy skills, executive function, social-emotional development; home and family environments	Direct and Parent or teacher survey	Population-based
International Development and Early Learning Assessment (IDELA; Pisani et al., 2018)	3.5 - 6	motor, numeracy, literacy, and social-emotional	Direct assessment	Population and program based

The majority of the tools mentioned in Table 1 are paper-based and suitable for program evaluations or at the population level but not individualized children support programmes, which is the focus of this dissertation. Apart from MELQO and EAP-CDS, others do not have a deliberate aim of assessing Approaches to Learning.

Apart from program-based evaluations of children's learning and development, other digital tools exist that assess individual learners' school readiness that has been tested in LMICs. A popular one and freely available is the National Institute of Health (NIH) toolbox that assesses the development of children in motor, sensory abilities, emotional and cognitive of 3-15 years age category (Zelazo et al., 2013). However, a few limitations of the NIH toolbox, such as tasks developed from adult versions and the requirement for direct online connectivity, led to the development of the Early Years Toolbox (EYT; Howard & Melhuish, 2017). The EYT measures language, executive functions, self-regulation and socioemotional development. EYT is iPad based, free to download and does not require direct connectivity to the internet. Additionally, it was specifically designed to fit children's assessments. EYT has also been used to assess executive functions in South Africa (Howard et al., 2020). However, despite the EYT's suitability for the LMICs, it is not an android-based platform most commonly used by telephone and tablet users in the LMICs such as Kenya.

2.1.4 Assessment of School Readiness in Kenya

The current 2-3-3-6-3 System of Education (Figure 1) came into being after the National Sessional paper 2 of 2015 recommended that the previous 8-4-4 system of education be revised (Republic of Kenya, 2015). The paper further introduced the new Competency-Based Curriculum (CBC). For the first time, the CBC was introduced in Kenya in 2017 to correct the weaknesses of the 8-4-4 system of education (KICD, 2017). Rather than focusing too much on content mastery and examinations, CBC focuses on the child's holistic development. It also addresses other transversal skills such as communication and collaboration, digital literacy, creativity and imagination, citizenship, learning to learn, critical thinking and problem solving (p.23).

The National Early Childhood Policy (2015) uses the term Early Childhood Development and Education (ECDE) to refer to services offered to children aged between 0 to 8 years (Figure 1). Early years' education in Kenya starts at the age of 4 in pre-primary I and five in pre-primary II. Children are assessed based on formative assessments in pre-primary II and I. Before the age of 4, parents are encouraged to take care of their children at home or take them to baby classes. The aim of these assessments is not to determine who will move to primary school but to identify weaknesses among the learners and ensure there is a 100% transition to school. These assessments are based on pre-academic skills in five learning areas: Mathematical activities, language activities, psychomotor and creative activities, environmental activities and religious activities (Basic Education Curriculum Framework, 2017).

Ministry of Education, 2015, launched the Kenya School Readiness Assessment Test (KSRAT; Republic of Kenya, 2017). This version had a small section of the Approaches to Learning scale with ten items rated from excellent to fair. The items covered the child's Approaches to Learning competencies in eagerness, self-drive, innovativeness and creativity. Later in 2019, after the launch of the Competency-Based Curriculum, Kenya School Readiness Assessment Test was revised to accommodate the new curriculum activities and assessment rubrics (see Appendix 2). The primary purpose of the Kenya School Readiness Assessment Test is to establish the level of competency of a learner in the different activity areas as they transit to grade 1 but not for ranking or exclusion of learners during the transition process. The revised Kenya School, Readiness Assessment Test, highlights the five learning areas: mathematical activities, language activities, psychomotor and creative activities, environmental activities, and religious activities (Republic of Kenya, 2019a). Each activity area is

assessed based on a scoring guide: exceeding expectations, meeting expectations, approaching expectations, and below expectations.

To complete the assessment tool, the assessor must refer to the learner's progress record developed in the year and the assessor's guide to complete the assessment tool. The learner's performance goes beyond the set target on a particular task to exceed expectations. For a learner to meet the expectation, the learner's performance must meet the set target when demonstrating the performances in a specific learning area. If the learner's performance meets most of the expectations of the set target of a teacher, the learner is approaching expectation. However, if the learner's performance exhibits the least of the teacher's expectations, the learner has achieved below expectation (Republic of Kenya, 2019b). Teachers are expected to use these results to fill out the Kenya School Readiness Assessment Test. The assessment is done informally through teachers' physical observations of the child's work samples. The results of this tool are supposed to help both the teacher in pre-school and primary school predict the child's school readiness. With this information, the primary school teacher will adapt the proper teaching methodology to fit the children to progress in primary school.

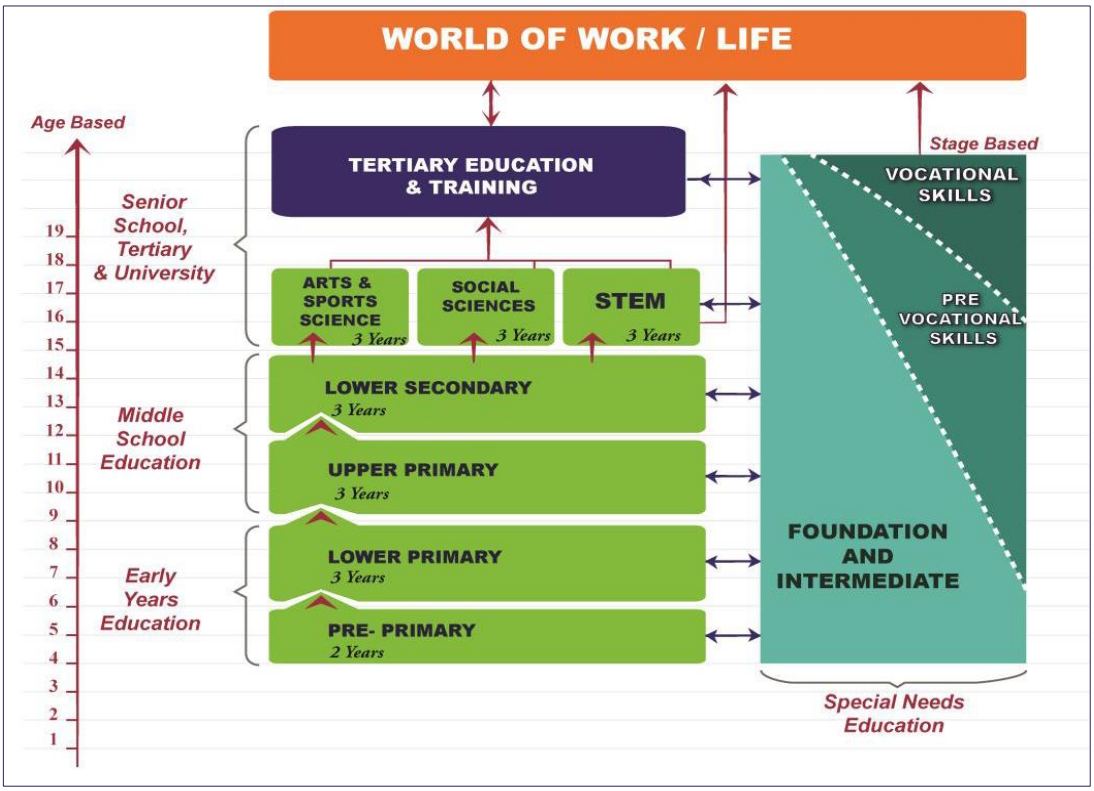
The Kenya School Readiness Test is yet to be used in many counties and schools due to logistical challenges, especially teacher training on how best to use the tool. In addition, many preschools have serious challenges with record keeping. Like many other school readiness assessment kits, Kenya School Readiness Assessment Test has prioritized subjects provided in the competency-based curriculum at the expense of socio-emotional and Approaches to Learning. The Kenya School Readiness kit does not assess either motivation or executive functions. It does not also assess approaches to learning.

After pre-primary, there are no special programs to enhance the transition to grade 1; many schools, especially private schools, conduct interviews to admit children in grade 1 (Figure 1). This is followed by three years of lower primary education that starts at the age of 6 years. Children are assessed based on formative and national assessments before joining middle school (upper primary and lower secondary). In addition, children with special needs are assessed and placed accordingly, either in the mainstream or special needs institutions. Another National Assessment will be done before joining the senior school at the age of 15. This assessment will also place candidates into three different bands: Arts and Sports Science, Social Sciences, Science

Technology and Engineering. Students will specialize at the University (Republic of Kenya, 2017, p.29).

Figure 1

Organisation of Basic Education in Kenya



Source. Basic Curriculum Framework (Republic of Kenya, 2017, p.29)

Kenya's Constitution, Article 53, affirms the right to free compulsory education (Republic of Kenya, 2010). The fourth schedule, Articles 185(2), 186(1) and 187(2) of the Constitution, distributes powers between the County Government and the National Government (Republic of Kenya, 2010). The Basic Education Act (2013) operationalises the Constitution by providing access to free and compulsory quality Basic Education to all children. Early Childhood Education is devolved to the County level while the Central Government manages primary, secondary and university education. In big cities like Mombasa and Nairobi, the majority of the children go to private schools rather than Government-owned schools (Piper et al., 2018). After enacting the new Constitution in 2010, County Governments now employ teachers approved by the Teachers Service Commission who have attained a three-year Diploma course in Early Childhood Development and Education. Previous primary teacher

graduates had attained a two-year certificate qualification in teacher education, which has now been replaced with a 3-year diploma in primary teacher education.

Despite all these efforts, the transition from pre-school to school is still a challenge. Other challenges that Early Childhood Education in Kenya faces include: (i) legal and policy framework; (ii) coordination, linkages and partnerships; (iii) Resources such as finance, physical/infrastructural facilities and human development; (iv) quality and relevance (v) Governance and accountability; (vi) access; (vii) attitudes towards gender and special needs children; (viii) health and nutrition (Republic of Kenya, 2017).

2.1.5 Empirical Studies on Assessment of School Readiness in Kenya

The Ministry of Education in Kenya has been developing programs to enhance school readiness. One of those programmes is the Tayari (meaning ready in Kiswahili) program (2014 - 2018), sponsored by the Children's Investment Fund and technical support provided by Research Triangle International (Piper et al., 2018). To estimate the project's impact on school readiness, the programs' schools were given equal treatment and then randomly assigned to treatment and control groups. Results indicated that the Tayari initiative improved overall school readiness by 5.1 index points and 9.6% more children met the school readiness benchmark. The three treatment groups were: (1) Training & Support; (2) Training & Support + Books/Teachers' Guides; and (3) Training & Support + Books/Teachers' Guides + Health. In this research, school readiness was defined as performance on the Kenyan version of the Monitoring Early Learning, Quality and Outcomes (MELQO) assessment, with ten areas of school readiness combined for an average school readiness metric, inclusive of executive function, language, numeracy, and socioemotional domains (p.66). MELQO was adapted and developed by UNICEF/UNESCO for use in Kenya. The tool has a set of items that can be administered at different times. This tool in Kenya has been termed as the Direct Assessment Tool for assessing literacy, numeracy, socioemotional and executive functions (Piper et al., 2018).

Mungai (2016) investigated the levels of parental involvement in the learner in preschools in Nairobi. The researcher developed a school readiness assessment test and a parent rating scale of parental involvement to assess school readiness. The results demonstrated that there was a correlation between parental involvement levels with school readiness as well as between the physical and social environment and primary school readiness. Also, the study revealed a significant but negative relationship

between the quality of harshness and detachment dimensions of teacher-pupil interaction and primary school readiness.

Ngaruiya (2013) investigated the effect of socioeconomic status (SES) on school readiness. SES was depicted by the economic and social resources, parents' education level, occupational status, and residence location. This information was collected using the Primary Caregiver Interview Schedule (PCIS). In addition, a composite score of the child's language measured school readiness and social-emotional competence was collected using the Pre-school Children's School Readiness Assessment Rating Scale (PCSRARS). The findings showed that family social capital exerted more effect on children's primary school readiness than financial resources.

Taken together from the above studies in Kenya, school readiness was measured using the following tools: (i) Kenyan adapted version of Measuring Early Learning and Quality Outcomes (Piper et al., 2018), (ii) Pre-school Children's School Readiness Assessment Rating Scale (Ngaruiya, 2013), (iii) Primary School Readiness Test (Mungai, 2016). However, none of the studies used the Kenya School Readiness Assessment Test directly, the officially documented school readiness test in Kenya (Republic of Kenya, 2017c). Furthermore, only one study by Piper et al. (2018) used the MELQO to assess executive functions. Nevertheless, this study assessed executive functions as a program based measure but not for individualised intervention. This study also did not assess mastery motivation.

Additionally, no studies specifically addressed mastery motivation, executive functions combined or approaches to learning for individualised intervention which is the focus of this study. Instead, teachers and parents filled paper-based tools on behalf of the child. The present study intends to introduce a tablet-based assessment to assess school readiness directly. A child scoring above normative score on pre-academic skills, mastery motivation and executive functions will be considered school ready.

2.2 Approaches to Learning

The National Education Goals Panel, formed in 1991, became the foundation for school readiness in the US. The panel advocated that readiness is child-centred; it can be enhanced via environmental interventions and represents ideas constructed by the community and the schools (National Education Goals Panel, 1991). Kagan and her colleagues structured school readiness into five dimensions: (1) physical well-being and motor development; (2) social and emotional development; (3) approaches toward

learning; (4) language development; and (5) cognition and general knowledge (Kagan et al., 1995; Kids Count, 2005; US Department of Education, 2014). Boivin and Bierman's (2013) definition of school readiness also identified cognition which is referred to as the cognitive domain by the National Education Goals Panel, covers acquired skills or knowledge of a particular subject such as number or letter recognition and processing skills or learning. Executive functioning is one of the general cognitive skills that facilitate learning in preschool classrooms.

Additionally, child language skills are critical in learning. They include both ability to listen and understand a particular language (i.e. receptive language skills) and communication with others verbally (i.e. expressive language skills). Another domain of school readiness is socioemotional skills that encompass cooperation between peers, teachers, social relationships, and behaviour problems. In the National Education Goals Panel definition, this domain is combined with emotions and refers to social and emotional development. Using the Early Childhood Development Index(ECDI; McCoy et al. 2016) reported that a third of children in LMICs are experiencing challenges in social-emotional development.

Both Sabol and his colleague and the National Education Goals Panel recognized Approaches to learning as a domain of school readiness. Further, Sabol and Pianta defined Approaches to learning "as a set of skills which reflect children's curiosity, flexibility, attention, persistence, and engagement" (p.5). The last is the physical health domain, referred to as physical well-being and motor development by the National Education Goals Panel. This domain addresses children's healthy behaviour practices and fine and gross motor skills. The focus of this dissertation is on approaches to learning, one of the domains that are critical in school readiness since it is related to the socio-emotional domain

2.2.1 Perspectives of Approaches to Learning in Literature

The term Approaches to Learning was first introduced by Marton (1976) to describe a series of experiments on levels of processing in which students read and recalled texts. To avoid confusion, Marton and Säljö (1984) adopted "approaches to learning" to replace the deep/surface dichotomy and level of processing they had initially used in their earlier experiments from 1976. The deep approach referred to students with an adaptive approach, interest, and excellent factual recall. The surface approach featured learners with low interest, high anxiety and poor factual recall.

Approaches to learning and the other five dimensions of school readiness were first introduced in early childhood research by the 2000 US *National Education Goals* Panel (Kagan et al., 1995). This was a response by the Technical Planning Group in the US to provide possibilities for measuring goal 1 of education (National Education Goals Panel, 1991; Snow & Van Hemel, 2008; Sabol & Pianta, 2017). This term has since been applied across the different levels of education, and due to its importance, it has attracted global attention (Zhang et al., 2021).

Apart from Kagan and her colleagues, other authors have also attempted to define Approaches to Learning. Below are some of the definitions of approaches to learning cited in recent literature from 2012 – 2019. Italics have been added for illustration purposes. In their study, Chen and McNamee (2011) defined Approaches to Learning in terms of *goal orientation, planfulness,* and *resourcefulness* of the learner. While McWayne et al. (2004) and Fantuzzo et al. (2018) defined Approaches to Learning as the observable behaviours and *individual characteristics* children show while participating in learning activities. Razza et al. (2015) also refer to Approaches to Learning as "learning to learn" skills and *dispositions* such as *persistence, motivation, task attention, and tolerance to frustration* that influence engagement with learning tasks in the daily classroom behaviour.

Further, Hunter et al. (2018) define Approaches to Learning as a foundational skill that helps children *persevere complex tasks*, respond to academic stimuli, and *solve problems creatively*. Other authors have defined Approaches to Learning as attributes that help children learn, such as *enthusiasm, self-regulation, persistence, motivation, interest, flexibility, initiative, reflection, attentiveness, cooperation, and independence* (e.g., Hyson 2008; Li et al., 2019; McDermott et al., 2012; Sabol & Pianta, 2017). These definitions presented by different authors have adopted related terms that are used to describe mastery motivation and executive functions. As we shall see later in this dissertation, mastery motivation can be explained by persistence, tolerance of frustration, motivation, cooperation, independence, and enthusiasm. In comparison, terms such as goal orientation, planfulness, task attention, solving problems creatively, flexibility, initiative, reflection, attentiveness, and self-regulation have described executive functions. Finally, some authors (e.g., Davis et al., 2021; Fantuzzo et al., 2004; Li-Grining et al., 2010; McClelland et al., 2006) also refer to Approaches Learning as self-regulated learning. Self-regulated learning is an umbrella term including motivational, cognitive, emotional/affective, metacognitive, and behavioural

aspects of learning. Extant literature has shown that executive functions and self-regulation are related but not the same. When executive functions are successfully implemented, it leads to successful self-regulated behaviour (Nigg, 2017). Therefore, self-regulation is composed of bottom-up activities, i.e. those that do not require mental capacity and top-down that require mental capacity, such as executive functioning. Additionally, apart from learning behaviours and dispositions identified by other definitions, Wickrama and Sung (2018) also included the affective ability to self-regulate in managing emotion, behaviour, motivation, and attention for learning in their definition of Approaches to Learning. Furthermore, conceptually, both learning and self-regulated learning approaches have measurement similarities (Davis et al., 2021).

Conceptually, in literature, different names refer to Approaches to Learning, including working approach (Chen & McNamee 2007), learning-related social skills (McClelland et al., 2006), academic enablers (DiPerna & Elliott, 2002), learning-related behaviours (Hyson, 2008), self-regulated learning and task orientation (Razza et al., 2015). Other authors refer to learning-related behaviours as enthusiasm for new tasks and persisting with new tasks in the face of challenges (McDermott et al., 2014), abiding with classroom routines and rules (Sung & Wickrama, 2018), engagement and involvement in-class activities (Brock et al., 2009), cooperation and independence behaviours (DiPerna,1999). Depending on how the authors defined approaches to learning, it also informed the methodology of its assessment.

2.2.2 Theoretical Framework of Approaches to Learning

According to Kagan et al. (1995), the rationale behind Approaches to Learning is that acquisition of skills, knowledge, and capacities do not guarantee a complete measure of a program and developmental success. First, having the knowledge or skills alone without the disposition to apply them in different learning situations does not guarantee its usage. Second, focusing too much on acquiring skills and knowledge undermines the motivation to use the very skills. Therefore, it is critical to focus on predispositions that affect Approaches to Learning, such as temperament, gender, values, and cultural patterns, which affect how children approach learning situations. Gender has been established to influence attitudes towards own abilities and subjects. These attitudes can potentially affect how one approaches a task such as mathematics or their potential abilities to handle such a task. Like gender, temperament also influences how learners understand, think, judge, perceive, and solve teaching and

learning situations. Tasks perceived to be easy are enjoyable instead of those that appear to be challenging, resulting in anger and frustration.

Further, our surrounding environment dictates what culture we subscribe to in that community. Cultural patterns and values dictate the different ways we learn and modalities. Some cultures encourage children to sustain dialogue with their parents or adults, while others provide more opportunities to receive instruction. These three predispositions contribute to the various learning styles children will adopt in one way or another. Kagan and his colleagues noted that apart from predispositions, learning styles,

> are malleable and include variables that affect how children attitudinally address the learning process: (1) their openness to and curiosity about new tasks and challenges; (2) their initiative, task persistence, and attentiveness; (3) their approach to reflection and interpretation; (4) their capacity for invention and imagination; and (5) their cognitive approaches to tasks (p.23).

From Kagan's definition of learning style above, it is easy to notice similar terminologies related to mastery motivation and executive functions. Item 1 and 2 are close descriptions of mastery motivation, while 3, 4, and 5 are to executive functions. Since learning styles differ from one institution to another, Kagan et al. (1995) emphasized more studies to understand Approaches to Learning so that teachers can diversify their pedagogical approaches to suit different types of learners. However, this area is still the least understood. For example, La Paro and Pianta (2000) conducted a meta-analysis of 70 longitudinal studies examining the predictive validity of non-cognitive skills to school readiness. From the 70 studies, only two featured approaches to learning and socio-emotional domains. All the others addressed cognitive skills. Educators can enhance young children's school readiness and success by responding to positive approaches that support learning. Children with poor Approaches to Learning are at risk of maladjustment, transitioning to school, and being more likely to be referred for special services than their peers. Thus, poor Approaches to learning serve as a risk factor, and positive Approaches to learning are protective factors (Vitiello & Greenfield, 2017). For example, in the US, this type of study is given a national priority (US Department of Education, 2000), and it is assessed in all 38 states except two (Barrett et al., 2017).

Borrowing from Kagan et al. (1995), Hyson (2008) developed the Approaches to Learning framework. In this framework, the construct of emotion/motivation is,

referred to as “Enthusiasm for learning,” which is composed of variables such as interest, pleasure, and motivation to learn. On the other hand, "engagement in learning” contains attention, persistence, flexibility, and self-regulation variables. Combining enthusiasm and engagement for learning, Hyson refers to the two as positive approaches to learning. As discussed in section 2.1.7, both enthusiasm and engagement cover similar descriptions of executive functions and mastery motivation. However, not all Approaches to Learning result in positive outcomes. There are instances when children can be disengaged or disappointed, leading to demotivation and negative reactions. These negative reactions are also described in mastery motivation as the affective domain. When the affective domains are positive and pleasurable, they are referred to as mastery pleasure, and negative reactions when not pleasurable.

2.2.3 Approaches to Learning Assessment Tools

Different methods have been used to assess Approaches to Learning, such as teachers’ reports, parent reports, and direct assessments (Ackerman, 2018; Li et al.,2019). Most of these reports rate children’s behaviour frequency in various classroom activities such as peer interaction or engagement with books (e.g., Barbu et al., 2016). First is the Preschool Learning Behaviors Scale (PLBS; McDermott et al., 2002) assesses three dimensions: learning strategy, competence/ motivation, and attention/ persistence. Second is the Child Behaviour Rating Scale (CBRS), commonly used in the states of Virginia and Oregon in the US to monitor children’s development of Approaches to Learning. The third famous tool is the Approaches to learning scale of the Early Childhood Longitudinal Study -Kindergarten Cohort’s ECLS-K which focuses on creativity, curiosity, persistence, organisation, and responsibility (Li-Grinning et al., 2010). Others include the High Scope’s Preschool Child Observation Record (COR: Brickman & Weiner, 2013), Devereux Early Childhood Assessment (DECA; Bulotsky-Shearer et al., 2013); Learning to Learn Scale (McDermott et al., 2011), and Arizona kindergarten readiness guardian(GQ) and teacher (TQ) questionnaires (Arizona Department of Education, 2005). Other studies adopted the school readiness tools such as the Head Start REDI (Research-based, Developmentally Informed) (e.g., Hunter et al. 2018). These tools are pen and paper-based. The value of these reports depends on the quality of information parents and teachers can produce. They have also been accused of being biased and affected by teacher beliefs (Sasser et al., 2015).

To compensate for weaknesses of teachers' and parents' reports as a form of assessment for approaches to learning, direct assessments have been proposed. Direct assessment (also called objective measure or direct observation) is where trained examiners observe children when handling tasks such as mathematics or reading. For example, the Bridging's Rating Scale for the working approach (BRS: Chen & McNamee, 2007), Approaches to Learning subscale of the East Asia-Pacific Early Child Development Scales (EAP-ECDS; Rao et al., 2014). In a multimethod study, Li et al. (2019) compared the three approaches to learning measures: parent report, teacher report, and direct assessment. Results indicated that direct assessment was more relevant to children's early childhood development than parent and teacher reports. Therefore, the study recommended using direct assessment and parent/teacher reports as supplementary.

For this reason, continuous assessment of Approaches to Learning using teacher/parent reports does not fully assess it (Józsa et al., 2017; Kagan et al., 1995; Li et al., 2019). Additionally, all the studies reviewed non-implemented computer-based assessments of Approaches to learning, mastery motivation, and executive functions either directly or through ratings. Also, the direct assessment measures require examiners who understand the construct under investigation. The following section discusses the association between Approaches to Learning and academic school readiness.

2.2.4 Relationship between Approaches to Learning and Academic Performance

Studies have demonstrated that positive Approaches to Learning are linked with higher reading and math performance, lifelong learning, academic school readiness, and long-term academic achievement (Beisly et al., 2020; Hyson, 2008; Sung & Wickrama, 2018). For example, Chen and McNamee (2011) examined ninety-two children in different classroom activities in various curricular areas. In this study, they rated children's performance in each of the seven activities (reading books, drawing a self-portrait, solving puzzles, playing number games, building a model car, moving to music, and experimenting with crayon techniques), which were scored using a criterion-referenced rubric (Chen & McNamee 2007). Results indicated that positive Approaches to Learning: initial engagement, focused attention, goal orientation, and planfulness effectively improved children's performance. However, another study by Dominguez

et al., 2011 reported that positive Approaches to Learning mediate negative setbacks to mathematics and literacy performance.

Further, Chen and McNamee (2011) studied Approaches to Learning development from prekindergarten to grade two based on a socio-cultural perspective. Sixty-one children were rated in five Approaches to Learning: initial engagement, focused attention, goal orientation, resourcefulness and planfulness, and participation in six classroom activities assessed using the Bridging Questionnaire (Chen & McNamee, 2007). Results showed that as children developed and classroom activities diversified, their Approaches to Learning also varied. This provides more support for diversified instructional techniques and curriculum activities. Moreover, learners who acquire Approaches to Learning behaviours during preschool years are better placed for a smooth transition to school (Li-Grining et al., 2010).

Bulotsky-Shearer et al. (2011) defined approaches to learning as persistence, curiosity, initiative, problem-solving, and engagement. This study reported that early problem behaviour is linked to lower academic outcomes such as mathematics and reading, lower attention, motivation, and persistence in academic tasks. This study assessed Approaches to Learning using the Preschool Learning Behavior Scale (PLBS; McDermott et al., 2002). Therefore, Approaches to Learning are negatively related to children's problem behaviour and positively related to their positive social skills. In another similar study, Vitiello et al. (2011), using multilevel analysis, reported that Approaches to Learning mediated cognitive flexibility and school readiness. In this study, Approaches to Learning were assessed using PLBS (McDermott et al., 2002).

Ziv, 2013 also sought to establish a link between Approaches to Learning variables, social information processing, and social competence with school readiness by conducting a short-term longitudinal study of 198 preschool children. Results indicated that social information processing and social competence were related to school readiness. In addition, social competence mediated between social information processing and school readiness. In this study, Ziv defined approaches to learning as developmental growth in early cognitive flexibility, attentiveness, and organization (e.g., Ziv, 2013). Additionally, Mattison, 2016 reported a significant relationship between Approaches to Learning and grade retention, suspension in later elementary grades, and special education enrollment.

Further, Nelson et al. 2017 reported that executive control (working memory, inhibitory control, and flexible shifting) predicted learning engagement. This study

agrees with Bassok et al., 2016 that asked preschool teachers to identify fundamental school readiness skills they believe children must have. Of most teachers, 91% identified following directions, and 77% noted paying attention. These two skills are crucial in the Approaches to Learning domain. Bustamante et al. (2017) conducted a longitudinal study to assess the potential of Approaches to Learning in predicting science in Head Start centres in low-income neighbourhoods. A total of 397 children from low-income families aged 3 to 5 years were involved in the study. Data were prepared and analysed using Structural Equation Modelling (SEM). The study results showed that Approaches to Learning significantly predicted gains in science and math but not vocabulary or listening comprehension for low-income children (Carlson, 2013; Li-Grining et al., 2010; McWayne, et al., 2004). In another study, McDermott et al. (2014) found that Approaches to Learning are associated with growth in reading and math achievement through fifth grade.

Additionally, Bustamante and Hindman (2019) reported that classroom quality assessed using CLASS (Pianta et al., 2008) predicted gains in teacher-rated Approaches to Learning using Early Childhood Longitudinal Study (U.S. Department of Education, 2002), which predicted gains in academic school readiness. These results agree with McDermott et al., 2012, which found external validity between Preschool Learning Behaviour Scale factor scores and future academic performance and learning behaviours. Furthermore, the multilevel logistic model demonstrated that these factors contribute to a low risk of future maladjustment and academic non-proficiency.

Hunter et al., 2018 conducted a longitudinal study to determine teachers' competency in brief rating tools for the predictive validity of Approaches to Learning and socio-emotion competence. The study adopted the following set of tools; School Readiness Questionnaire developed for the REDI, which included nine Approaches to Learning items, the social competence scale, a test of preschool early literacy, kindergarten and early grade adjustment and achievement tests. This study established that teacher-rated Approaches to Learning predicted kindergarten and first-grade academic outcomes, grade retention, and supplemental services.

Sung and Wickrama (2018) adopted latent growth curve modelling to study executive functions, Approaches to Learning, and math achievement from Kindergarten to first grade. A teacher questionnaire measured Approaches to Learning; Teacher Social Rating Scale was explicitly developed for this study. The tool provided a mean score of six items on how children demonstrated learning behaviour, eagerness

to learn, organization, learning independence, attentiveness, following the rules, persistence, and adaptation to changes. Children who exhibited positive Approaches to Learning had higher scores. Results showed that a faster growth rate in Approaches to Learnings and executive functions corresponded to higher math and reading achievement. Additionally, executive functions, directly and indirectly, influenced academic achievement through Approaches to Learning.

Buek (2019) examined the growth of Approaches to Learning from kindergarten to second grade as predicted by family and parenting characteristics. This study was based on Transactional development theory (Sameroff, 2009). Teachers rated each child by completing the Social Rating Scale that explains how the child displays the following behaviours: keeps belonging organized, works independently; shows eagerness to learn; readily adapts to changes in routine; persists in completing tasks; pays attention well, and follows classroom rules. Results revealed that sex (male) and poverty were linked with lower Approaches to Learning trajectories, while the presence of both parents and parent involvement both at school and home predicted higher Approaches to Learning. Taken together from the initial review, Approaches to Learning has a strong relationship with school readiness and academic achievement.

2.3.0 Components of Approaches to Learning: Mastery Motivation and Executive Functions

Recently, authors have identified mastery motivation and executive functions as essential components of Approaches to Learning, which lay a foundation for academic achievement and school success (e.g., Barrett et al., 2017; Berhenke et al., 2011; Buek, 2019; Duncan et al., 2018; McClelland & Wanless, 2012). Both enthusiasm and focused persistence when handling challenging tasks are the primary measures of Approaches to Learning and mastery motivation. In addition, mastery motivation shares characteristics with executive functions, another component of Approaches to Learning (Barrett et al., 2017). Extant studies have shown that these variables are linked with Approaches to Learning domains and contribute to learners' achievement more than demographic and cognitive variables such as IQ, expressive and receptive vocabulary, parental education, and income (Barbu et al., 2016). However, most studies have not utilized mastery motivation or executive functions in assessing Approaches to Learning. We, therefore, operationalized approaches to learning to be equivalent to mastery motivation and executive functions for this study.

Surprisingly, mastery motivation has explicitly received very little attention in school readiness literature (Józsa & Barrett, 2018) and motivation among children in general (Cooper 2014). Authors have also observed a paucity of research on the associations between motivation and executive functions (Eisenberg et al., 2010; Finch & Obradović, 2017; Peterson & Welsh, 2014; Torgrimson et al., 2021) or in mastery motivation as an intervening variable (MacPhee et al., 2018). Further, some studies have reported that children from low SES have a low mastery motivation approach to learning and academic skills (Garcia, 2015). Why children from low SES have low mastery motivation is also unclear, with some researchers pointing at the economic stress that parents suffer that denies children opportunities for diversity and modelling (Turner & Johnson, 2003). Since mastery motivation is malleable (McDermott et al., 2014) and students with low SES benefit the most from such interventions (Drotar et al., 2009), strategies to improve mastery motivation in early childhood might help close SES gaps.

Although mastery motivation and executive functions are malleable, they are also different. mastery motivation involves a child's attitude/approach toward learning and performance, challenge, enthusiasm/desire for mastery, feelings of autonomy and positive or negative attempts during these mastery attempts (e.g., Barrett & Morgan, 1995; Ratelle, Guay, Larose, & Senécal 2004). Mainly mastery motivation interventions focus on the learning process but not performance by encouraging autonomy and affective- teaching (e.g., Sakiz, 2017; Schiefele & Schaffner, 2015). In addition, studies have shown a close relationship between mastery motivation and executive functions. mastery motivation leads to better executive function by allowing the learner to keep a goal in mind as she struggles to use various problem-solving strategies (Hauser-Cram et al., 2014). The following section discusses the construct of mastery motivation and, later, executive functions as components of Approaches to Learning.

2.3.1 Mastery Motivation

Researchers have focused on motivation (MacTurk et al., 1995), self-regulation, and persistence that support school success (Finch & Obradović, 2017). A recent review of 74 studies on the relative significance of motivation and intelligence demonstrated that motivation and intelligence accounted for 24%, motivation alone for 4% and interaction of motivation and intelligence another 4% of the variance in academic achievement (Demetriou et al., 2020). One of the constructs of this effort in early

childhood is mastery motivation. Pintrich and Schunk defined motivation as “the process whereby goal-directed activity is instigated and sustained” (2002, p. 5). On the other hand, mastery motivation is "the urge or psychological "push" to solve problems, meet challenges, and master ourselves and our world" (Barrett & Morgan, 2018, p.4). Initially, mastery motivation is intrinsic, but individual differences occur due to environmental and genetic differences (Morgan et al., 1990). mastery motivation is multifaceted, with central aspects of it being instrumental behaviours, such as persistent task- or goal-directed behaviour, and affective/expressive behaviours, such as mastery pleasure and angry/frustrated or sad/ashamed responses to challenge” (Barrett & Morgan, 2018, p.6). In addition, mastery Motivation focuses on persistence when solving moderately challenging tasks and engagement with people and objects during learning (Busch-Rossnagel & Morgan, 2013). Therefore, we operationalised mastery motivation for this study to refer to the time taken while solving moderately challenging tasks. A moderately challenging task is a task that is neither too easy nor too difficult for a child of that particular age. We also operationalised mastery motivation as the child's performance on the Preschool DMQ 18. This is one reason mastery motivation is considered necessary in approaches to the learning dimension of school readiness (Fantuzzo et al., 2004). Therefore, mastery motivation is a crucial developmental concept that should be part of a child’s evaluation (Morgan et al., 2019, p. 26).

2.3.2 Mastery Motivation and other related Motivation Approaches

Mastery Motivation is closely related to but not the same as achievement goals theory, expectancy-value approach, and self-determination theories of motivation (Józsa et al., 2019). The achievement goals theory addresses why students will be motivated to be engaged in some tasks and not in others(e.g., Haimovitz & Dweck, 2016; Harackiewicz et al., 2012). It involves the aspects of mastery and performance goals (Anderman & Wolters, 2006). Those with mastery goal orientations see *failures* as temporary setbacks that provide opportunities for growth and learning. In contrast, those with a performance orientation believe that failures indicate a lack of ability. They, therefore, find failure devastating. On the other hand, Mastery motivation is more concerned with the process and attempts to master challenging tasks and its inclusion of multiple mastery domains that should not necessarily relate to academic achievement. mastery motivation also involves instrumental and expressive/affective aspects (Barrett & Morgan, 2018). One similarity between the mastery of goals and

mastery motivation is that one persists despite failing to achieve goals and persists despite experiencing challenges/difficulties (Józsa, 2018). In the expectancy-value approach, the emphasis is placed on the value of the activity and the expectation that one will succeed (Eccles et al., 1983). Whether one succeeds is not essential in mastery motivation, but persistence is critical (Barrett & Morgan, 1995). Self-determination theory, in turn, focuses on autonomy, relatedness, and competence (Deci & Ryan, 2017). In contrast, mastery motivation treats self and relationships as mastery domains and the inclination to master as a motive in itself (Józsa & Molnár, 2013). Mastery motivation also assesses other broad domains, including the cognitive, social, and physical domains. The same person can have different mastery motivation s in different domains. For this reason, it is essential to observe mastery motivation as a process in context (Wang & Barrett, 2013).

2.3.3 Multifaceted Nature of Mastery Motivation

"Multifaceted" refers to the fact that mastery motivation occurs in and may differ across various contexts and domains (Barrett & Morgan, 1995; Hwang et al., 2017; Józsa, 2014; Wang & Barrett, 2013). These domains are (1) cognitive, a child's motivation to persist and master cognitive and school-related tasks; (2) gross motor, the motivation to master athletic skills; and (3) social, the motivation to master interpersonal relations with adults and with peers (Morgan et al., 1995). The second aspect of its multifaceted nature is that mastery motivation comprises both expressive/affective and instrumental aspects. The instrumental aspect of mastery motivation is usually depicted by persistence while handling a challenging task. Persistence during problem-solving also depends on the developmental maturity of attentional skills, cognitive skills, behavioural skills; executive functions; and specific task-related skills. These skills are interconnected. Instrumental aspects also include goal-directed persistence and a preference to control and influence the environment (Barrett & Morgan, 1995; Wang & Barrett, 2013). The other aspect of mastery motivation is the expressive/affective aspect that includes interest, pleasure, and pride in trying to master or mastering that also must be assessed to comprehend Mastery Motivation. This aspect also includes anxiety, frustration/anger, shame, and sadness, at more minor or non-successful mastery (or expectation of failure) (Barrett & Morgan, 2018). Biological needs or drives do not cause motivation unless it triggers emotions, resulting in motivational behaviour (Pekrun et al., 2006). Positive emotions promote

persistence and mastery attempts, while negative emotions such as shame and sadness motivate avoidance or giving up (Józsa & Barrett, 2018).

Role Emotions in Motivation

Emotions, moods and affect have been used differently in emotion studies (Plass & Kaplan, 2016). Borrowing from different authors, Roseman (2011) conceptualized emotions as *syndromes* characterized by the following components, which he referred to as response types: (1) Phenomenological component (specific thoughts and feelings); (2) Physiological component (characteristic bodily response patterns); (3) Expressive components (specific manifestations in face, voice, and posture); (4) Behavioral component (action tendencies); (5) Motivational component (corresponding goals). Therefore, combining these five components constitutes a strategy for that emotion. Each emotion syndrome observed is a strategy to cope and adapt to a specific situation. The mood, on the other hand, as defined by Russell (2003), is an ongoing free-floating affect that is not associated with any object. Therefore, there is a difference between moods and emotions. Moods do not have a single identifiable source or cause, like emotions. Emotions mostly have a single identifiable source, starting point and end. Affect is used interchangeably with emotions, although in practical terms, it affects how we feel, while emotion is the result of the feeling (Hoffman, 2015). Emotional experience follows a learned pattern. Firstly is the interaction between the person and the environment. Secondly, a subjective and localised cognitive appraisal occurs. Thirdly, the bodily responses will accompany the emotional activation. Finally, the body and mind unite, leading to physiological and motor responses (Russell, 2003).

Rash et al. (2016) point out that many emotions are elicited during mastery situations. Such emotions may encourage or stop children from pursuing a task. Such emotions are not due to similar thinking or emotional attributes, but the emotions themselves *affect* motivation. Consequently, this will change the motivational behaviour positively or negatively depending on the valence. Emotion realigns with a particular behaviour (Hoffman, 2015).

For this reason, mastery motivation is divided into instrumental and affective aspects. The affective aspects assess emotions exhibited during mastery tasks. For example, if the task is enjoyable or easy, children will be happy, which will be indicated

by a smile, i.e. mastery pleasure. On the contrary, if the task is difficult or frustrating negative reactions will be exhibited, such as sadness or anger (Barrett & Morgan, 1995).

2.3.4 Assessment of Mastery Motivation

In early childhood, mastery motivation is assessed utilizing free play (McCall, 1995), structured-mastery tasks (Yarrow et al., 1983), individually determined, moderately challenging tasks (Green & Morgan, 2017), and questionnaires (Józsa & Morgan, 2015). Recently, the game-based assessment was introduced to assess mastery motivation (Józsa et al., 2017). Moreover, four sets of questionnaires are available to assess mastery motivation: the infant questionnaire for 6- to 23-month-olds is scored by adults; the preschool questionnaire for 2- to 6-year-olds is scored by adults; the school-age questionnaire is either scored by adults or self-reported; and the adult questionnaire is self-reported. Questionnaires have an advantage since the rater – for instance, the teacher, parent, or caregiver spends much time with the child on structured tasks and free play. Mastery motivation can be assessed using task-based or behavioural measures. Firstly, assessing mastery motivation in the context of free play (Morgan et al., 2020). Today, this approach is not very common because other children in the neighbourhood join, which might affect the results. Secondly is the use of structured mastery tasks. Yarrow et al. (1983) operationalised mastery motivation as the amount of task-directed behaviour during the presentation of a set of objects that posed a challenge. The procedure was to explain or demonstrate the operation of a particular object to the child for 3-5 minutes, then let the participant proceed without interruption. The infant behaviour was coded to record inattention, general exploration, task- or goal-directed behaviours and indexing motivation. The third method is the Individually Determined, Moderately Challenging Tasks. The child's motivation is assessed using a moderately challenging task that was not very difficult but allowed the child to finish the level as they move towards more challenging tasks. mastery motivation was measured by the child's persistence and pleasure in the task (Barrett et al., 1993). This was called the individualised approach since it separated ability from motivation (McCall, 1995). With this advancement, Shonkoff and Philips (2000) recommended that the developmental evaluation of young children include mastery motivation.

The task-based measures have several strengths. First, the structured task has the benefit of observing all learners performing the same task, thus making it easier to notice learners facing challenges. The second one, structured tasks, allow comparing

children who are developing typically or atypically or children of different developmental ages. Finally, structured tasks can also facilitate longitudinal studies. However, task-based measures have some limitations. First, there are no social and motor tasks. Second, it also assumes that all children will find the tasks equally challenging to meet or test. Third, it is difficult to tell what will happen if the child completes the task before the trial. Fourth is the desire to please the tester. Lastly, it is not ecologically valid since the children do not choose the task like in the case of free play (Barrett & Morgan, 2018).

The second category of mastery motivation assessment is the use of Questionnaires. The teacher or the parent rates their perceptions of the child's behaviour in mastery situations since they have an opportunity to observe a child over a more extended time and in various settings. This can augment laboratory observational measures. This tool has been used to assess over 20,000 children from 6-months to 19-years old from the United States, Canada, England, Australia, Hungary, Taiwan, Mainland China, South Korea, Kenya, Israel, and the Netherlands (Morgan et al., 2020). The Dimension of Mastery Questionnaire (DMQ) had earlier versions, such as the MOMM (Mother's Observation of mastery motivation) and DMQ 1 to 17). The MOMM questionnaire was developed for 1- to 5-year-old kids in the 1980s. The scale was assessed as high vs low mastery motivation. There was a significant revision to improve the psychometrics and age appropriateness of the questionnaire without losing the strengths (Barrett & Morgan, 2018).

Besides the ease of data collection, DMQ has different versions to assess individuals at different ages, as early as infancy, even within the same framework. Hence, children's mastery motivation at different ages can be measured and compared based on the same theoretical construct. Moreover, the DMQ can investigate cross-age correlations and provide domain-specific stability of mastery motivation on the same landscape. Nevertheless, DMQ has one weakness; a mature adult fills the DMQ on behalf of the child. As a result, sometimes their memory and interpretation of events could be wrong, and they fill their perceptions rather than the child's actual behaviour (Józsa & Morgan, 2014). Currently, DMQ 18 is the latest after DMQ 17 was revised.

2.3.5 Relationship Between Mastery Motivation and Academic Performance

Learning to read is foundational for further learning (Centre for Public Education, 2015). Children who do not attain a proficiency level in reading by third grade are more likely to remain underachievers in high school (e.g., Shaywitz et al., 1992) and are four times more likely to quit high school (Hernandez, 2011). On the other hand, children who underperform in maths by sixth grade are more likely to drop out of secondary school (Balfanz et al., 2007). Due to this significance, more research to identify individual-level predictors that affect reading and mathematics is necessary. Unfortunately, maths and reading development does not occur in isolation; other factors in the children's learning environment are critical. Further, domain-specific curriculum interventions alone have limits in enhancing academic achievement (Ribsen, 2020).

Both cross-sectional and longitudinal research has demonstrated that mastery motivation, specifically cognitive persistence, can predict school achievement (Józsa et al., 2019). In cross-sectional studies, Józsa and Molnár (2013) and Józsa (2014) found that the cognitive persistence scale of mastery motivation is associated with academic achievement. It also predicted academic achievement better than developmental scores in children with developmental disabilities (Gilmore & Cuskelly, 2009). In another first and third graders sample, mastery motivation was related to reading and mathematics (Broussard, 2004). Longitudinally, the cognitive persistence scale in grade 4 also predicted school-related skills (Gilmore et al. 2003), language and math skills (Martin et al. 2013; Mokrova et al. 2013), as well as grade point average (GPA) in grade 8. Besides, Mercader et al. (2017) reported that mathematics achievement in the second grade was significantly predicted by persistence in completing a challenging task in pre-school.

Moreover, Berhenke et al. (2011) also found that shame, an influential aspect of mastery motivation, was positively correlated with social competence and math and reading skills, while persistence was the strongest predictor of school readiness. Children who demonstrate persistence at challenging tasks can easily follow directions and cooperate with peers during learning activities (Finch & Obradović, 2017; Pomerantz et al., 2005). Due to the significant role of mastery motivation in school readiness is considered a building block for readiness to learn and academic achievement (Sabol & Pianta, 2012).

However, this connection depends on how the two variables are measured. The following methods are helpful in this regard: (i) use of standardised developmental or

intelligence tests (e.g., Yarrow et al., 1983); (ii) asking caregivers to rate their child's ability in daily activities, which is the indicator of general competence in the DMQ (Morgan et al., 2009). Persistence has a more direct impact on competence than does the expressive aspect of mastery motivation. Age is another factor that affects the empirical correlation between mastery motivation and competence. As the children get older, mastery motivation weakens (Morgan et al., 1995). Also, the time interval when measuring two factors in longitudinal studies is essential to consider.

Apart from age, other factors related to ratings of mastery motivation include; cultural comparisons on DMQ, children with and without developmental delay, parents' education, and gender differences (Józsa & Molnár, 2013). The literature supports that mastery motivation, primarily cognitive persistence, is related to school-related skills such as reading, mathematics, and GPA cross-sectionally and longitudinally.

2.3.6 Strategies for Mastery Motivation Enhancement and Interventions

Mastery motivation enhances school readiness and academic achievement in early elementary education. The individualized, moderately challenging tasks can be used to identify the tasks that are neither too easy nor too difficult for the child to support their future competence. For example, tasks that children cannot achieve a 10% success rate are complex, while they quickly accomplish over 90% are too easy for that child (Wang et al., 2017). Another procedure is to assess the level of engagement with the task and the negative reactions exhibited. Additionally, practitioners can administer tasks based on developmental ages and accompanying tasks that fit that age. Task difficulty can be adjusted by modifying feedback, content, and practice conditions (Guadagnoli & Lee, 2004). Moderately challenging tasks help distinguish between motivation and developmental challenges in the learner (Morgan et al. 1992). Apart from tasks, other strategies for promoting mastery motivation for effective early childhood intervention and school services is to understand the use and application of the DMQ 18. The DMQ 18 can provide helpful information regarding the child's motivation towards adults, peers, and the surrounding environment.

Since mastery motivation is malleable, its enhancement is possible through interventions. First, practitioners can adopt a "One Step Ahead" approach where only the necessary support is provided to help the child achieve the next level of competence. Apart from improving mastery motivation, such strategies improve executive functions, language, and cognitive development (Mermelshtine, 2017). Caregivers can

also apply motivational procedures based on the Pivotal Response Treatment approach (Koegel et al., 2012). This procedure involves following children's choice of play materials to capture their interest. Second, separate the task to be learned from already mastered tasks. The third option is to adopt natural reinforcers directly related to the learning task. Lastly, provide reinforcers to goal-directed activities.

Mastery motivation interventions can also focus on the learning process by encouraging autonomy and affective teaching (e.g., Sakiz, 2017; Schiefele & Schaffner, 2015), help the child see the value of trying and supporting learners' efforts (e.g., Vansteenkiste et al., 2004) as well as eliciting curiosity (e.g., Stahl & Feigenson, 2015). Teachers should offer challenging tasks just enough, not too much above the child's level or too low (Józsa et al., 2017). Further, the feedback and framing of learning activities children receive from teachers determines whether they will continue to pursue those challenges, especially when they become difficult (Kamins & Dweck, 1999). Therefore, teachers should praise the process rather than the outcome (Dweck, 2003). Additionally, teachers should offer incentives when it is necessary or delay the feedback to allow the child an opportunity to continue trying (Waldman-Levi & Erez, 2014). Instead, harness learners' natural curiosity and interest to achieve a particular realistic learning goal rather than a reward (Grant & Dweck, 2003). Children who have experienced demographic risks also benefit from a warm and quality teacher-child relationship (e.g., Hamre & Pianta, 2005; Meehan et al., 2003). It is, therefore, critical for teachers to offer quality teaching and learning processes that will enable children to develop positive learning behaviour to mitigate the effects of family demographic risks and increase educational opportunities (Hu et al., 2017).

Other mastery motivation researchers have identified environmental influences such as parental control and negativity (Busch-Rossnagel & Morgan, 2013; Marshland, 2005), quality of the home environment in terms of providing challenging toys and activities (Jennings & Dietz, 2003; Wang et al., 2011), as well as opportunities for diversity and modelling (Turner & Johnson, 2003). Moreover, play should be encouraged since it helps children release stress and get actively involved in learning (Milteer & Ginsburg, 2012). However, even though toys and other computer-based play materials are provided, they should not replace social interaction during learning (Russo-Johnson et al., 2017). This can be enhanced by providing children with some agency to decide what fits them since children pursue tasks that they have some level of self-determination (Stipek, 2011). In addition, these strategies can help close the

socio-economic gap since they are linked to later school readiness (MacPhee et al., 2018). Children with special needs practitioners and teachers can enhance mastery motivation by following the 5-SEMM(five steps for enhancing mastery motivation) approach: problem identification; problem explanation with parent/child; select goals; propose motivation enhancing strategies; and shared outcome evaluation (Liao et al., 2020).

2.4.0 Executive Functions

Executive Function is a term that refers to "the abilities to inhibit a well-learned but undesirable response (inhibitory control), hold thoughts in mind while problem-solving (working memory), and modify strategies to adjust to changing goals (cognitive flexibility)" (Józsa & Barrett, 2018, p. 83). Other authors have described executive functions as "the brain's air traffic control system" (Center on the Developing Child, 2011). Despite these differences, neuroimaging research indicates that all Executive Function components are essential for learning (Sung & Wickrama, 2018). Therefore, scholars are keen on identifying contextual factors that influence children's executive functions development (Schirmbeck et al., 2020). According to Hartanto et al. (2019), some factors include bilingualism, socioeconomic status, and parental scaffolding.

Significance of Executive Functions

The quantitative and qualitative values assigned to a student after the process of teaching and learning indicate the academic performance and the ability of the brain to facilitate this process (Vermunt & Endedijk, 2011). For this reason, Zelazo and Carlson (2012) suggested that executive functions should be studied since it is vital in language development, processing, and organization of received information. Researchers also agree that executive functions are essential for a successful transition to kindergarten, which focuses on many assessment programmes (Blair & Razza, 2007; Barrett et al., 2017). Besides, Berhenke et al. (2011) also showed that motivation, executive functions, and emotion regulation play a crucial role in the preschool to kindergarten transition. Similar results were also found on the role of executive functions in school readiness (e.g., Beck et al., 2011; Ng et al., 2015). Executive Functions and visual-motor coordination have also significantly predicted later academic achievement up to grade 2 (Ober et al., 2018). Other studies have also indicated that attention, one of the skills in executive functions, is associated with individual differences, which is linked

with school readiness and predicts later academic achievement (Duncan et al., 2017). Executive functions have been applied in other studies, such as social functioning, self-regulation, cognitive abilities, human performance and psychometric studies (Baggetta & Alexander, 2016). The predictive power of executive functions is also better than that of IQ (Blair & Razza 2007); even when IQ and SES are controlled, the predictions are still evident in the long run (Moffitt et al., 2011). Strong executive functions support children's Approaches to Learning (Sung & Wickrama, 2018; Vitello, 2011).

2.4.1 Executive Function Models

To conceptualise executive functions, several models and their components have been proposed. The review of theoretical models (Barkley, 2012) identified 33 different models that had borrowed the construct of executive functions in their descriptions. Lezak (1995) proposed an executive functions framework composed of planning, purposive action, volition and effective performance. Similar to Lezak, Anderson, 2002 developed a model composed of four domains: attentional control, goal setting, inhibitory control and informational processing. Miyake et al. 2000 model was different from Lelak's but very close to Diamond's 2006, which identified shifting, updating, and inhibitory control as the main components, while the Diamond 2006 model recognises inhibitory control, working memory and cognitive flexibility. Another early attempt is Zelazo et al.'s 1997 problem-solving framework that included problem representation, planning, execution and evaluation. This framework resembled the Lezak (1995) and Anderson (2002) framework in many aspects. Zelazo et al. 2003, on the other hand, demonstrated that the hot and cool model of executive functions is composed of cognitive control, problem-solving, emotional control/regulation, working memory, attentional control, planning, monitoring and inhibitory control.

2.4.2 Components of Executive Functions

Despite different definitions and models in the literature, researchers agree that executive functions have three components, working memory, inhibition control, and cognitive flexibility (Diamond & Ling, 2019). The evidence for the three components originates from factorial analyses (Milyake, 2000) and neuroimaging findings (Smolker et al., 2015). Although different, cognitive flexibility, working memory and inhibition are highly related. As a result, some authors have treated them as a unitary construct (Griffin et al., 2016; Jacob & Parkinson, 2015). Therefore, to test the dimensionality of executive functions, the factor analytic approach is advocated to assume executive

functions constructs as latent variables and cannot be directly measured but inferred from various tasks administered (Willoughby & Hudson, 2021).

Inhibitory control allows one to choose one task amongst other competing tasks or impulsive thoughts to meet the desired goal. It includes self-control, selective attention, unwanted behaviour or instinct and interference control (Diamond, 2013; Diamond & Ling, 2019; Friedman & Miyake, 2004). Working memory involves holding information in mind and updating and working with it, whereas cognitive flexibility is the ability to switch between tasks and flexibly adjust due to new rules or demands (Diamond, 2013). Working memory has been associated with sound reasoning and problem-solving abilities, while cognitive flexibility to creativity or "thinking outside the box" and inhibitory control to patience before deciding (Diamond & Ling, 2019). Fundamentally, it is challenging to separate working memory, inhibition and cognitive flexibility in early childhood (Griffin et al., 2016; Józsa & Barrett, 2018; Karr et al., 2018). Researchers argue that, during complex cognitive tasks like problem-solving, the three components of executive functions work together (Diamond, 2013; Zelazo et al., 1997). Despite these differences, neuroimaging research indicates that all components of executive functions are essential for learning (Sung & Wickrama, 2018). Executive Functions depend on the prefrontal cortex, which is vulnerable to environmental factors such as poverty, loneliness and stress (Arnsten et al., 2015; Hackman et al., 2015; Harms et al., 2018). Some authors have indicated that poor executive functioning or impairment is associated with Attention Deficit Hyperactivity Disorder (ADHD: Barkley, 1997; Willcutt et al., 2005) and linked to poor academic achievement (Molfese, 2001).

Role of Emotions in Executive Functions

Miyake and Carson (2012) hypothesized that executive functions are composed of cool and hot executive functions. Cool executive functions involve situations of problem-solving that do not require motivation or an affective component. On the other hand, hot executive functions require children to delay gratification or decide due to emotions or motivations. Studies have shown that cool executive functions(inhibition, working memory and cognitive flexibility) in preschool can predict math (e.g.,Clark et al., 2010), literacy (De Franchis et al., 2017) or both (Blair & Razza, 2007) and are more generally related to academic achievement and classroom-related behaviours (Brock et al., 2009). However, depressed affect or mood has effects on executive functions. For

example, people tend to ‘think outside the box or be creative when they are happier, while sadness and loneliness affect attentional control and reasoning (Diamond & Ling, 2016).

2.4.3 Self-Regulation and Executive Functions

In developmental psychology, self-regulation is a broad concept encompassing executive functions and the regulation of impulses from below to the top (Blair & Raver, 2012). Blair and Raver (2015) define self-regulation as a set of processes or behaviours that an individual engages in to achieve a specific goal. Such processes include feelings, actions and self-generated thoughts planned and organized to achieve a personal goal (Zimmerman, 2000). Therefore, behavioural self-regulation applies executive functions in particular social contexts, for example, in the classroom where learners will lift their hands rather than shout an answer or in real-world situations. Extant literature has adopted self-regulation differently depending on the affiliation of the scientist or the application of the tools selected for measurement. According to Bailey and Jones (2019), self-regulation is based on two multi-component skills, executive functions from Neuropsychology and Effortful Control from the field of temperament. Regulation devoid of emotions is referred to as “cold”, which captures executive functions, while in the presence of emotions is “hot” and is captured by executive control. The model proposed by Bailey and Jones (2019) is also supported by Gagne et al. (2021). Both models agree that working memory is specific to EF, while executive attention (attention focusing and attention shifting) and inhibition belong to executive functions and executive control. Therefore, Bailey and Jones (2019) propose that executive control and executive functions partially overlap, while Gagne and his colleagues suggest they share common features. Some recent studies have also proposed that both EC and EF are components of Self-regulation (e.g.,Lin et al., 2019; Kälin & Roebers, 2021; Schmidt et al., 2022).

Relationship between Self-Regulated Learning and Executive Functions

Self-regulated learning is an umbrella term including motivational, cognitive, emotional/affective, metacognitive, and behavioural aspects of learning. Studies have also depicted EF as a domain-general enabler of learning-related behaviours within self-regulated learning (Roebers, 2017). Several authors have reported a substantive correlation between executive functions and self-regulated learning. For example,

Sasser et al. (2015) reported r = .40, N=164 among prekindergarten children and Sung and Wickrama (2018) observed in a large sample of N= 18,170 an association of r = .53. Others have reported the predictive ability of EF after one year, such as Nesbitt et al. 2015, (*r*s between.11 and.19) for different behaviours and Brook et al. 2009, r = .35, N = 170.

2.4.4 Assessment of Executive Functions

Many methods have been used to measure executive functions in literature, either behaviour-based or performance-based tasks. For performance-based tasks, the most common tasks include different variations of Stroop task such as colour/word, day/night, large/small; digit span; go/no-go task; trail making task; army individual test battery; n-back task (see Baggetta & Alexander, 2016; Carlson, 2005 for a review) and peg-tapping task (e.g., Welsh et al., 2010). Performance-based tasks are the gold standard in the assessment of executive functions. Unfortunately, most of these direct assessments involving paper and pencil are cumbersome and require trained examiners primarily unavailable in LMICs (Willoughby et al., 2019). While the performance-based assessment assesses the underlying cognitive abilities, the rating scales evaluate the application of these cognitive skills in diverse areas such as the home and school. The two measures tap different cognitive levels; reflective and algorithmic levels. The reflective is concerned with the goals of the system and its relevant beliefs, while the algorithmic measures how the brain processes information (Toplak et al., 2013). Whereas laboratory measures draw from the algorithmic mind and measure the optimal/maximal performance, ratings draw from the reflective mind and measure the typical performance and application of those skills at school or home (Isquith et al., 2013; Toplak et al., 2013). Studies have shown that assessment of executive functions using laboratory measures and ratings have small correlations (e.g.,Camerota, 2018; Catale et al., 2015), indicating that both assess different aspects of executive functions (Camerota et a., 2018; Catalle et al., 2013; Willcutt et al., 2005).

Ratings have one advantage since they assess executive functions over an extended period as opposed to laboratory measures and can be used to assess many participants (Józsa & Józsa, 2020; Thorell et al., 2013). Additionally, laboratory measures have limited ecological validity, and the contextual demands of these two types of assessment on the child are different (Ten Eycke & Dewey, 2016; Toplak et al., 2013). The most commonly used and researched questionnaire is the family of

Behavioral Rating Inventory of executive functions (BRIEF: Roth et al., 2014) scales with 86 items and, recently, Barkley Deficits in Executive Functioning (BDEFs: Barkley, 2012). However, the BRIEF is commonly used to identify children who might develop ADHD in future. A much simpler one with 24 items, although not widely used, is the Childhood Executive Functioning Inventory (CHEXI: Thorell & Nyberg, 2008). The BRIEF has one advantage since it has normalized data that researchers can compare, but unfortunately, it is too long, and it comes at a cost compared to the CHEXI, which has 24 items and is freely available online (Camerota et al., 2018). Nevertheless, the CHEXI is a valuable screening tool for identifying children at risk of ADHD, early academic difficulties and Executive Function deficits (Thorell et al., 2013). Besides, the BRIEF is mainly used to identify learners that might develop ADHD in future (Thorell & Nyberg, 2008). Another instrument used to assess executive functions and famous in temperament is the Children's Behaviour Questionnaire (CBQ; Rothbart et al., 2001). This tool has subscales measuring attentional focusing, impulsivity and inhibitory control. A fourth Instrument is a Five-to-Fifteen questionnaire covering executive functions, Perception, Language, Motor Skills, Memory and Learning. Others include the Executive Skills Questionnaire (ESQ; Dawson & Guare, 2010), Amsterdam Executive Function Inventory(AEFI; Van der Elst et al., 2012) and Dynamic Occupation Assessment of Executive Function (DOAF; Chubarov et al., 2015). Despite the utility of these tools, more than 95% of EF assessments in the LMICS have adopted laboratory-based assessments (Obradović & Willoughby, 2019). Due to several advantages of the CHEXI, it was adopted as a tool to assess executive functions for this study. In addition, the newly designed FOCUS app was used as a performance-based measure of executive functioning.

2.4.5 Executive Functions and Academic Achievement

Executive Functions are linked to children's school success in two pathways, first, through the acquisition of problem-solving skills, mathematics and reading (Foy & Mann, 2013; Kolkman et al., 2013). Second, by enhancing adaptive classroom behaviours such as emotional control, following rules, focusing on the task, organizing material, and participating in group activities (Clements & Sarama, 2019; McClelland et al., 2007). Some meta-analytic studies have also reported a mild association between executive functions and academic achievement (e.g. Allan et al., 2014; Pascual et al., 2019). This association between Executive Function skills and early school readiness

factors supports enhancing those skills to improve school readiness, especially for children from different socioeconomic backgrounds (Sasser et al., 2017). The qualitative and quantitative values indicate academic performance as a construct a student obtains after teaching and learning. This indicates the ability of the brain to facilitate this process (Vermunt & Endedijk, 2011). For example, when one solution is not working during learning, cognitive flexibility allows one to change or shift to another one that might offer a solution. On the other hand, working memory is required for updating new information while still cognitively engaged in challenging tasks. Therefore, for one to keep focus on the current task, Inhibitory control is required to ignore other competing tasks or responses (Sung & Wickrama, 2018). Several studies using the CHEXI have shown a significant association between executive functions and academic achievement (e.g.,Thorell & Nyberg, 2008; Thorell et al., 2013). However one study found no relationship between CHEXI subscales and cognitive tasks (Catale et al., 2013).

Some meta-analytic studies have also reported an association between executive functions and academic achievement (see Cortes et al., 2019 for a review). Further, studies have consistently reported that executive functions contribute to reading and mathematics across age groups, specifically working memory (e.g.,Christopher et al., 2012; Vandenbroucke et al., 2017). On the other hand, other studies have reported that inhibition is related to math and reading achievement (e.g.,Vandenbroucke et al., 2017) while others did not (e.g.,Blair & Razza, 2007; Lee et al., 2012). These contradicting results call for more studies using different sample sizes, children's ages, assessment methods and data analysis (Jacob & Parkinson, 2015).

Neuroimaging findings have revealed that the three components of executive functions are directly involved in the process of learning (Sung & Wickrama, 2018), especially mathematics (Clements & Sarama, 2019), but the mechanism is still unclear (Mulcahy et al., 2021). For example, inhibitory control is responsible for paying attention to instructions, interfering with the current ongoing task to assess progress, avoiding distraction, and focusing on learning tasks (Sasser et al., 2015). The ability to follow complex and sequential instructions depends on working memory (Nesbitt et al., 2015), and strategic monitoring in the process of handling academic tasks requires children to flexibly shift attention between their work and internal goal, which is a function of cognitive flexibility (Davis et al., 2021).

Longitudinal studies have also indicated that executive functions and mathematics predict each other over time but not literacy (Schmitt et al., 2015), and the association is much stronger for preschoolers with low math performing competencies (Dong et al., 2020). During preschool years, executive functions promises support for school readiness because (1) they grow fastest during this period; (2) they are malleable; (3) they are linked with improved academic and socio-emotional outcomes (Mattera et al., 2021). Further, enhanced executive functions lead to improved learners' ability to self-regulate, which is associated with the adaptive Approaches to Learning, one of the domains of school readiness and more vital academic skills in school up to sixth grade (McClelland et al., 2006; Raver & Knitzer, 2002). Extant literature reveals that executive functioning is related to academic achievement. However, most of these assessments were done in the West and adopted laboratory-based assessments (Nakamichi et al., 2021).

2.4.6 Executive Functions Interventions and Enhancements

Executive Function interventions focus on cognitive switching, inhibitory control and working memory skills (e.g., Bierman & Torres, 2016). School-based interventions to Improve executive functions fall into four groups: behavioural, socio-emotional learning, play and direct training, and improving cognitive skills related to executive functions (Mattera et al., 2021). In the behavioural model, teachers are responsible for setting classroom rules, routines, discipline, and expected approaches that govern children's behaviour and learning. In addition, the teacher-child relationship is critical since it moderates behaviour and emotions (Raver et al., 2007). The US's Incredible Years teacher training program (Webster-Stratton et al., 2004) adopted this approach to reinforce teacher-child relationships, classroom management, and concrete approaches for supporting learners' behavioural and emotional regulation. Other similar interventions that focused on high-quality instructional practices and classroom management procedures include the work of Bierman et al. (2008) and Raver et al. (2011).

Another approach to improving executive functions and socio-emotional readiness is social information processing (SIP: Crick & Dodge, 1994) and emotion theory (Izard, 2009). SIP theory posits that children's ability to identify problem-solving and emotional situations guides them to suitable social responses with their peers. On the other hand, emotion theory hypothesizes that children's knowledge of emotions

helps them identify emotional situations and address them. These enhanced self-regulatory and emotional awareness co-occur with Executive Function improvement. For example, the US's Promoting Alternative Thinking strategies (PATH) program in the US was modelled on helping children identify emotions, strategies for self-regulation, and possible solutions to social situations (Mattera et al., 2021). Additionally, the Head start CARES program tested three approaches for enhancing socio-emotional development (Mattera et al., 2013), Incredible years teacher training program, preschool PATH and Tools of the Mind-play.

Specific cognitive skills related to executive functions can also be improved. Such programs focus on cognitive or pre-academic skills (maths and reading) but not socio-emotional skills. Although the focus is not directly on executive functions, there is evidence of a spillover effect into executive functions. For example, engaging with math problems and sequencing skills may support inhibitory control and working memory (Blair & Razza, 2007). Other studies have shown that high quality and effective teaching of maths activities helps to improve math and executive functions since children learn executive functions skills while engaging in mathematics (Mulcahy et al., 2021). There are three hypothesised mechanisms for mathematics instruction improving executive functions. First, math learning allows learners to practice executive functions skills according to the theory of hierarchic interactionalism (Sarama & Clements, 2009). Second, other academic domains do not provide mathematics scaffolds for executive functions process enhancement. Third, early math is joyful and playful, naturally appealing to children, thus improving executive functions skills (Mulcahy et al., 2021). For example, the Building Blocks Math instruction program was found to have spillover effects on preschool executive functions (Clements & Sarama, 2019). Further, the enhancement of mastery motivation leads to better executive functions by allowing the learner to keep a goal in mind as they struggle to use various problem-solving strategies (Hauser-Cram et al., 2014).

Interventions that promote play and direct training aim at children practising executive functions skills differently. For example, Tools of the Mind (Diamond et al., 2007) is a curriculum with tasks that train children on self-regulation throughout the day. TOM helps children regulate their attention and behaviour, interact with peers, and plan their play, thus removing whole-class instruction. Effects of Tools of the Mind on executive functions have been mixed (Mattera et al., 2021). Other direct training includes Red light/Purple light Circle time games (McClelland et al., 2019), including

a set of music and games that aim to enhance self-regulation skills. The games are played in increasing complexity for 15 -20 minutes for eight weeks targeting inhibitory control, working memory and cognitive flexibility. Reflection has also been shown to improve executive functions training. This occurs when one stops the current ongoing thinking and pauses to identify the previous steps they have undertaken and any point of concern or participating in a pretend play (Zelazo, 2015). Other direct training strategies include martial arts, mindfulness and Montessori teaching (Diamond & Ling, 2016) and children pretend to play in peer interaction (e.g.,Diamond & Lee, 2011). One of the most researched computer-based interventions is Pearson's Cogmed Working Memory Training (www.cogmed.com). Cogmed is implemented under the guidance of Cogmed coaches for 25 – 35 minutes for five weeks. The training involves visuospatial and gamified verbal tasks that require trainees to practice their working memory by remembering longer sequences of information due to their improved performance (Simons et al., 2016). However, computerized working memory training does not improve flexibility, self-control, or creativity (Harrison et al., 2013).

2.3.6.1 Executive Functions Interventions in Kenya

Executive Function interventions in Kenya have received mixed results. The Children's Investment Fund carried out the Tayari program (2014-2018) in Kenya, where the participating schools were placed into three treatment groups: (1) Training & Support; (2) Training & Support + Books/Teachers' Guides; and (3) Training & Support + Books/Teachers' Guides + Health (Piper et al., 2018). Although school readiness improved by 5.1 index points, executive functions scores were not associated with the Tayari program (Willoughby, Piper, Oyanga, et al., 2019b). In another study, Willoughby et al. (2021) conducted a cluster randomized controlled trial study employing RedLight/PurpleLight intervention program as a follow up to their previous school readiness enhancement program. executive functions were assessed using the Executive function Touch (Willoughby et al., 2019) computerized program. The results showed that there was no significant difference between the post-pretest results of experimental and control groups. They associated the null results to measurement and contextual issues.

Although there has been some success, some studies have registered mixed results regarding the ecological validity of Executive Function interventions. Nevertheless,

several lessons can be learned from successful interventions. Mattera et al. 2021 argue that teacher training in managing classrooms is not the only way to improve executive functions. Instead, the focus should also be placed on teacher behaviour management strategies and targeting maths skills through lessons. Specific Executive Function skills training and practice are ineffective as creating a holistic classroom environment allows Executive Function strategies to be embedded into daily activities (Mulcahy et al., 2021). Such strategies include martial arts and curricula that train and practice daily diverse executive functions skills have shown more hope than computerized training (Blair & Raver, 2015). Other studies have shown that executive functions can be improved by adjusting children's everyday experiences after identifying a child's emerging abilities (Howard & Melhuish, 2017). Such interventions applied in the child's daily activity have better ecological validity (Blair, 2017).

Additionally, measurement of executive functions ranging from behavioural regulation (teacher reports) to performance-based measures (e.g.,pencil tap) to computerized assessments (e.g.,hearts and flowers) have also been blamed for mixed results. In a review of studies of whether executive functions interventions have had benefits, Diamond and Ling (2016) concluded that: (1) Executive Functions transfer is narrow; (2) Executive Functions gains on the amount of time spent practising; (3) Some strategies show positive results in one context and "same strategies" fail in other contexts may be explained by the way the activities are presented and conducted; (4) Executive Functions used needs to be challenged; (5) Most Executive Functions interventions improve the learners who were the poorest in executive functions skills, with ADHD, and low SES; (6) benefits accrue from excises with cognitive demands. Further, it is difficult to disentangle whether lack of effect is occasioned by study methods, poor theorizing or other challenges (Mattera et al., 2021). Nevertheless, interventions that benefit executive functions must be conscious that the prefrontal cortex is sensitive to stress, loneliness, anxiety, sadness and poor health. Stress causes the adrenal cortex to release cortisol, which significantly impacts the prefrontal cortex and reduces connectivity with other brain regions. Thus, indirect strategies that reduce things that impair executive functions will have better results. Therefore, efforts to improve sleep, increase joy, social cohesiveness, physical fitness, and social support enhance executive functions (Diamond & Ling, 2016).

2.5.0 Computer-Based Assessment of School Readiness for Individualised Intervention and Enhancement

Most school readiness assessments are pencil and paper-based, whose accuracy depends on the examiner, teachers or parents. Some direct assessments require trained examiners to administer and interpret who primarily are not available in LMIC (Willoughby et al., 2019). Apart from the internationally recognized school readiness tools mentioned in section 2.1.2, some countries have started to adopt technology-based school readiness assessments. For example, Hungary has computerized the DIFER and studied the effects of delivery mode (Csapó et al., 2014). DIFER has seven tests: social skills, writing speech sounds, discrimination, relational reasoning, deductive reasoning, inferential reasoning, and counting skills. These tests are significant in determining school readiness at the beginning and predicting academic success in future (Józsa 2016). Since this test is not compulsory, it is administered to a third of the students or teachers who might think they are disadvantaged (Education Authority, 2016). Based on the DIFFER results, teachers administer DIFER improvement programs that enhance cognitive and social skills among disadvantaged children (Józsa, 2016; Józsa, 2014). However, the DIFER is not game-based.

A form of direct assessment that could be administered without intensive training of examiners is a computerised game-like, self-administered assessment. There has been much effort to develop a technology-based assessment to suit children (Csapó et al., 2014; Neuman & Neuman, 2019). However, this effort has historically been complex due to young children's low computer skills and developmental level, raising validity issues (Csapó et al., 2014; Suleiman et al., 2016). This challenge has significantly been reduced by introducing touchscreen technology that is highly accessible, portable with digital measurement abilities, ease of use, relatively low cost and engaging to children (Semmelmann et al., 2016).

Further, as the child touches the screen rather than typing on the keyboard, it significantly reduces the cognitive load on the child (Howard & Okely, 2015). Additionally, the ability of the tablet to receive accessories such as headphones allows the tasks to be self-administered since the participants can listen to the instructions. This reduces the cost of hiring people to administer the tasks and collect results (Diamond et al., 2013). However, children have been the most targeted group for digital games on computer tablets (Chaudron et al., 2015; Rideout, 2017), suggesting that game-based assessments on computer tablets might effectively assess school readiness skills in

young children. Therefore, there have been calls to develop tools that are easy to administer by the teachers and the children (Diamond et al., 2013). Furthermore, with the advent of technology, a computerized form of direct assessment can help automate the adaptive administration of tasks and collection of data. A form of direct assessment that could be administered without intensive training of examiners is a computerised game-based or game-like self-administered assessment.

2.5.1 Computer-Based Assessment of Executive Functions

Several computer-based assessments have been used to measure executive functions. Such technologies can collect data conveniently without necessarily asking an adult to rate a child (Józsa et al., 2017). This also cuts the enormous costs of constructing a laboratory for assessing such domains. In addition, there are commercially computer-based batteries of tests that are useful in assessing executive functions. They include the CANTAB, which measures executive functions as a subset of other cognitive measures developed by Cambridge Cognition and Delis-Kaplan, Executive Function System (D-KEFS) (Homack et al., 2005) and the National Health Institute (NIH) Toolbox Cognition Battery (Zelazo et al., 2013).

However, computer-based assessments of EF validated in the LMICs do exist. For example, the Executive Function Touch (EF Touch) is a structured laptop computer tool designed for 3-5-year-old children that administers eight EF tasks: Bubbles, Arrows, Houses, Silly Sounds Game, and Something's the Same, Pig, Pick the Picture, Farmer. Arrows and Pick the picture have been validated and used in Kenya (Willoughby et al., 2019). Limitations of this method include its use of a laptop rather than an android app, requiring internet access and usually using a mouse rather than a touch screen. In addition, EF touch has been normed for only 3-5-year-old children. This is problematic in the current Kenyan environment, in which 3 out of 10 preschool children, especially those in rural areas, are over age (Uwezo, 2021).

Another similar tool validated in South Africa is the Early Years Toolbox (EYT), a free-to-use digital application assessing early self-regulation, executive function, language, and social-emotional development (Howard & Melhuish, 2017). The iPad tablet-based app uses the "Mr Ant" task to assess visual-spatial working memory, the EYT "not this task" to assess phonological working memory, and the EYT Go/No-Go task assesses inhibition. This task requires participants to perform tasks based on auditory instructions. However, despite the EYT's suitability for the LMICs,

it does not assess mastery motivation and is not android-based, the platform most telephone and tablet users use in the LMICs, especially in Kenya.

Therefore, although two tools for assessing EF in LMICs do exist, neither measures mastery motivation, and the assessments require hardware and software that often are not available in LMICs or are not appropriate for the full age range of the early learning population in Kenya.

2.5.2 Game-Based Assessment of School Readiness Domains

It is estimated that there are more than 1000 computer-assisted interventions for children (Axelsson et al., 2016). Moreover, about 80% of the Apple Store's best-selling apps are for pre-schoolers or education (Papadakis & Kalogiannakis, 2017). Given this heavy consumption of video games and apps, parents and teachers have consistently inquired about their effects on young children (Behnamnia et al., 2018). Studies indicate that playing games is positively related to developing cognitive skills, motivational and academic performance (e.g.,Chan et al., 2017), and attention (e.g.,Godwin et al., 2015). However, the application of tablets and these apps to assess learning in children is less known (Carson, 2017), despite the potential advantages of this approach (Neumann & Neumann, 2019). Although emerging evidence suggests that mastery motivation and executive functions are critical components of approaches to learning, few studies have employed them to assess school readiness and approaches to learning. Further, the few Executive Functions-Tablet based assessments are either too long and cannot be combined with other measures or require trained examiners to interpret them. Additionally, some of the executive functions tablet assessments are affected by reaction time, which is a less relevant skill in executive functions assessment (Barrett et al., 2017).

2.5.3 Theoretical Framework of Game-Based Assessment

The Evidence-Centered Design (ECD: Mislevy et al., 2006) is instrumental in guiding the design of GBA. ECD belongs to a category of assessment frameworks referred to as principled assessment designs. These frameworks require evidence throughout the design, development and implementation, and their validity evidence is more robust than conventional assessments. Other similar frameworks include Cognitive design systems, Assessment engineering, Berkeley Evaluation and Assessment Research (BEAR) Center assessment system, and Principled design for efficacy. The ECD is the most widely recommended, implemented, and researched

among these frameworks. The other frameworks are often used in large item banks and secondary and undergraduate education (Ferrara et al., 2017). In fact, the latest framework, the Principled Design for Efficacy, is an adaptation of ECD that is primarily used in the assessment of summative end of year exams (Nichols et al., 2016). ECD has also been successfully implemented to manage game-based and simulation assessment challenges (Kim et al., 2016).

The ECD framework asks fundamental questions common in any assessment: "what, where, and how are we measuring, and how much do we need to measure" (Kim et al., 2016, p. 3). ECD answers these questions in four models. The first one is the student or competency or proficiency model (e.g., Almond et al., 2015) that stipulates the competencies and other student attributes that we want to measure, in this case, school readiness domains. Second is the task model, which indicates the set of activities that the learner will undertake to demonstrate those domains. The task model answers the question of where (during what activities) we measure the competencies. The third is the evidence model that connects the student's activities to the competence we wanted to know about the learner. This model provides specific metrics to answer the question: How do we measure the domains based on the task completion of activities representing the construct under investigation? Finally, the evidence model comprises two components: the scoring and measurement models. The connection between work products from learner activities and evidence from students' performance makes the assessment valid (DiCerbo, 2017). The competence, task and evidence model is also referred to as the Conceptual Assessment Framework (CAF: Mislevy et al., 2006). The fourth component is the Assembly model. This model stipulates how the CAF models will work together to generate enough evidence to measure the construct under investigation (Almond et al., 2015). There are proposals to expand ECD by incorporating learning into the four models to form an expanded ECD or e-ECD, although they have not been actualised (Arieli-Attali et al., 2019).

2.5.4 Why Game-Based Assessment?

Children are naturally playful, and therefore games are crucial in their development (Bento and Dias, 2017; Bers, 2020). With the advent of GBA, teachers and researchers can assess knowledge and various skills and abilities that are difficult to determine using traditional assessment methods by integrating them into those games. Players also experience motivation, behaviour change and deep engagement in

these games, providing more reasons for this medium's success (Chan et al., 2017). GBA focuses on collecting, analysing, and extracting information from data obtained while playing serious games. This concept is borrowed from Educational Data Mining (EDM), also known as Learning Analytics (Alonso-Fernández et al., 2019). The use of games in assessment has many advantages. First, they can adopt a real-life scenario to which the learner can relate, thus increasing their motivation assessment accuracy and reducing dropout rates and test anxiety (Barab et al., 2010). Secondly, touch screen technology emulates children's constructivist model of learning (Orfanakis and Papadakis, 2014). A study across Britain, Australia, New Zealand and the US reported that 2-5-year-olds could operate apps better than biking or shoe lacing (Grose, 2013) even before reading(Rose et al., 2017). Besides, many computer games share some common characteristics with academic assessments: evidence identification as proof of knowledge and its accumulation; presentation and finalising of activities to accomplish some goal, and presentation of another, usually more challenging activity once one completes the previous activity (Mislevy et al., 2012). Usually, to play a game, a player must apply various competencies or other attributes (e.g., creativity, problem-solving, persistence, and collaboration), so success in playing could measure those domains and other learning outcomes (Caballero-Hernández et al., 2017).

On the other hand, de Klerk (2015) reported two shortcomings of GBA. Firstly, the interaction of sound, contrasting colours and graphics can affect a child's concentration, especially in a high stakes assessment. Secondly, the amount of process data generated during a game is enormous, making it challenging to identify the elements under investigation.

There are three types of GBA. First is scoring game-related success measures, such as obstacles overcome, targets achieved, or the time taken to complete a task (Chaudy et al., 2013). The second is an external assessment that uses pre-post questionnaires, debriefing interviews, essay and knowledge maps, and test scores from multiple-choice questions (Caballero-Hernández et al., 2017). The third is an embedded assessment based on player response data, such as the use of click streaming or log file analysis and information trails (Ifenthaler et al., 2012). These assessment types are also integrated into GBA in six main approaches: adopting assessment models, monitoring states, quests, non-invasive assessment, quizzes, and peer assessment (Chaudy et al., 2013).

2.6.0 Research Gap

The literature review identified several gaps related to mastery motivation, executive functions and school readiness assessments. Several tools have been developed for school readiness assessments in the LMICS. Most of these tools were developed to evaluate school readiness programmes and are population-based but not for individual child school readiness assessment, intervention and support. For example, the Early Childhood Development Index (ECDI; McCoy et al., 2016), Regional Project on Child Development Indicators (PRIDI; Verdisco et al., 2014) and the East Asia-Pacific Early Child Development Scales in Asia (EAP-ECDS; Rao et al., 2014) are program-based. Others include the South African Early Learning Outcomes Measure (ELOM; Snelling et al., 2019), Measuring Early Learning Quality and Outcomes (MELQO) and Development and Early Learning Assessment (IDELA; Pisani et al., 2018). Apart from IDELA, the others depend on the teacher/parent to rate the child but not direct child assessment. In addition, other tools that support individual assessments, such as Kilifi Development Index (KDI; Kitsao-Wekulo et al., 2016)) do not assess motivation or approaches to learning. However, the Early Development Index(EDI; Janus & Offord, 2007) assess Approaches to Learning, but it is teacher-rated based on school assessments but cannot be used outside the school. As indicated elsewhere in this study, such assessments have shortcomings related to examiner biases, beliefs and inability to remember critical information about the child. Another inexpensive iPad tablet-based tool in the LMIC that offers child based direct assessment of school readiness is the Early Years Toolbox (EYT; Howard & Melhuish, 2017). Nevertheless, EYT is not Android-based; the platform is mainly used by the majority of the users in the LMIC and does not measure motivation.

Most studies on mastery motivation and executive functions have been done in western countries, and very little is known about executive functions in developing countries. The few studies on executive functions in Kenya did not combine it with mastery motivation or academic achievement. There are no studies on the topic of mastery motivation in Kenya at all, and therefore even available tools have not been customised to suit the Kenyan context. In addition, the study of approaches to learning has utilised reports assessing items different constructs of approaches to the learning domain. The utilisation of mastery motivation and executive functions to assess approaches to learning is extremely rare.

The methodology of executive functions assessment is mainly done using performance-based tools that only assess the underlying executive functions abilities but not their application at home and school or in combination with motivation. Such studies are primarily cross-sectional, and very few longitudinal studies on preschool children's evaluation of Approaches to Learning. Such direct assessments are time-consuming, expensive, and require trained examiners to administer instead of self-narrated, computerised assessments. Additionally, most studies on executive functions have failed to recognise the role of motivation in executive functions (Peterson & Welsh, 2014) and particularly mastery motivation in executive functions performance (Józsa et al., 2017).

Finally, some researchers have indicated that uncertainty still exists about which type of covariates to include so that there is a direct link between executive functions skills to academic outcomes (Jacob & Parkinson, 2015). Also, the mechanism of how it improves school preparedness is still not precise (Willoughby, Piper, Oyanga, et al., 2019a). There is also a controversy about whether, to sum up, inhibition control, working memory, and cognitive flexibility to develop an executive functions composite index or to treat them separately (Vitiello & Greenfield, 2017). There is also a lack of consensus on the concept of approaches to learning and self-regulated learning. However, most of the authors used both self-regulated learning and approaches to learning interchangeably, suggesting they are similar or the same.

Similarly, the definition of approaches to learning was also noted to combine mastery motivation and executive functions. We, therefore, hypothesize that mastery motivation and executive functions are two vital components of approaches to learning. This dissertation aims to contribute to this research gap.

CHAPTER 3

AIMS OF THE RESEARCH AND EMPIRICAL STUDIES

This chapter is divided into two subsections; research aims and research questions. The dissertation addresses five research aims covering six empirical studies focusing on developing and adapting tools for assessing learning and school readiness approaches. For each aim that formed a study, some research questions were developed. However, one study used the hypotheses to test the contribution of mastery motivation and executive functions to academic performance.

3.1 Research Aims and Empirical Studies

The study's overall goal is to enhance school readiness assessment in the Kenyan context by developing an android app to measure pre-academic skills, mastery motivation and executive functions to complement existing tools. Towards this goal, the study developed five research aims. First, to identify and develop a form of direct assessment for school readiness that could be administered without the need for intensive training of examiners. Second, develop and adapt tools for behavioural assessment of mastery motivation and executive functions in Kenya. Third, to determine the association between executive function difficulties and academic performance of grade one pupils. Fourth, to examine the direct and indirect effect of mastery motivation and executive functions on the academic performance of pupils during the transition to grade 1. Fourth, determine the predictive ability of mastery motivation and executive functions for school readiness when directly assessed and when rated using DMQ 18.

This research had six different studies. In study 1, we conducted a scoping review to identify whether there is any performance-based assessment of school readiness domains with a specific focus on mastery motivation, executive functions and Approaches to Learning in literature. This study was very instrumental in identifying the development designs, assessment procedures, and intervention strategies adopted by similar studies. In this study, over 2098 records were carefully synthesized to establish the gap in the literature regarding the game-based assessment of Approaches to Learning. Study 2 responded to the established gap in the Approaches to Learning literature. The study aimed to redesign and develop an app identified in study 1, i.e.

Finding Out Children Unique Strengths (FOCUS) app. After developing it to fit Kenyan culture, the app was piloted in study 2 and applied in a longitudinal study. Study 3 adopted and validated the newly translated Dimension of Mastery Questionnaire 18 (DMQ; Morgan et al., 2020) to Kiswahili to suit the Kenyan context. These tools are extremely useful in assessing mastery motivation in school and at home and can complement the direct assessments of mastery motivation; Study 4 adapted the Childhood Executive Functioning Inventory (CHEXI; Thorell, & Nyberg, 2008) to fit the Kenyan context. This study also sought to determine the association between academic performance and executive functioning using the Kenyan sample. Study 5 determined the contribution of mastery motivation and executive functions to the academic performance of grade 1 children. Finally, study 6 compared the predicting ability of directly assessed mastery motivation using the FOCUS App and the ratings based on Preschool Dimensions of Motivation Questionnaire 18.

3.2 Research Questions and Hypothesis of the Studies

3.2.1 Research Questions for Study 1

Study 1 aimed to investigate how Game-Based Assessment of School Readiness Domains is represented in literature and the existing literature gap. This study was a Scoping Literature Review. The following are the research questions that it addressed.

RQ1/S1: What are the main characteristics of Game-Based Assessment studies of school readiness domains?

RQ2/S1: Which countries have more studies in Game-based Assessment of school readiness domains?

RQ3/S1: Which knowledge, skills or abilities related to 3-8-year-old school readiness are assessed?

RQ4/S1: Are these assessments done in schools or outside contexts?

RQ5/S1: What measurement type and instruments does each assessment adopt?

RQ6/S1: What are the psychometric properties of these tools?

RQ7/S1: What type of performance data analyses are employed by these studies?

RQ8/S1: Is performance data analysis designed to analyse a process or product type of data?

RQ9/S1: How is the outcome of the GBA used to enhance the development of school readiness?

The answer to these research questions will help advise teachers, parents and game developers on the level at which GBA can be implemented to assess school readiness, the gaps available and how to seal these gaps.

3.2.2 Research Questions for Study 2

Study 2 was a longitudinal study that covered two related studies in preschool and grade 1. Study 2a evaluated the psychometric properties of the FOCUS app in the Kenyan context at preschool II. Study 2b assessed the application of the FOCUS app when the children were in grade 1.

RQ1/S2: What is the validity and reliability of the newly redesigned FOCUS app in Swahili to fit the Kenyan context?

RQ2/S2: Is there a relationship between pre-academic skills assessed using the FOCUS app and academic performance in Grade 1?

RQ3/S2: Is there a relationship between pre-academic skills and Mastery Motivation in preschool and grade 1?

RQ4/S2 Is there a significant difference in academic performance from preschool to school?

RQ5/S2: What is the predictive ability of the pre-academic skills task of the FOCUS app and academic performance in grade 1?

3.2.3 Research Questions for Study 3

Study 3 adapted and validated the Swahili version of the Dimensions of Mastery Questionnaire 18 since there was no tool to assess mastery motivation in the Kenyan context, especially among parents who were not competent in English.

RQ1/S3: What are the psychometric properties of the preschool Dimension of Mastery Questionnaire 18 when translated to Swahili in the Kenyan Context?

RQ2/S3: Is there a significant difference in the rating of the Preschool Dimensions of Motivation Questionnaire 18 by parents and teachers?

RQ3/S3: Is there a significant difference between male and female students concerning their mastery motivation in the Kenyan context?

RQ4/S3: Is there a significant difference between preschoolers who have met the age requirement for Preprimary II and those above the minimum age?

RQ5/S3: Is there a significant difference between DMQ 18 ratings of the Kenyan sample and the available preliminary norms?

3.2.4 Research Questions for Study 4

Study 4 examined the relationship between the Childhood Executive Functioning Inventory (CHEXI) and Academic Performance in Kenyan First Graders. This study was also used to determine the psychometric properties of the CHEXI in the Kenyan context. This study answered the following research questions.

RQ1/S4: What is the factor structure of the Childhood Executive Functioning Inventory (CHEXI; Thorell & Nyberg, 2008) in the Kenyan context?

RQ2/S4 What is the measurement invariance of the CHEXI based on gender?

RQ3/S4 Are there Executive Functions deficits among Kenyan first-graders in public and private schools?

RQ4/S4 Is there an association between Executive Functions and academic performance among Kenyan First Graders?

3.2.5 Research Questions for Study 6

Study 6 compared Assessment of Approaches to Learning using the FOCUS app and Behavioural Ratings of mastery motivation and Executive Functions. The following are the research questions for this study.

RQ1/S6 What is the validity and reliability of the revised number and letter recognition for the assessment of pre-academic skills?

RQ2/S6 What is the ability of the FOCUS app's number and letter recognition tasks to measure pre-academic skills across different schools and ages of children in the Kenyan context?

RQ3/S7 Determine the longitudinal growth of pre-academic skills from preschool to grade 2

RQ4/S8 Between the FOCUS app direct assessment of mastery motivation and School Preschool Dimensions of Motivation Questionnaire 18, which had a better predicting power of academic performance in the Kenyan context?

RQ5/S6 What is the ability of pre-academic skills in the FOCUS app to predict academic performance in grade 1?

3.2.6 Research Hypotheses for Study 5

Study 5 is set to investigate the influence of mastery motivation and executive functions on the Academic performance of First Graders. This study theorized that both mastery motivation and executive functions are essential components of Approaches to Learning. Thus, we hypothesized as follows;

H1/S5: Mastery Motivation has positive independent effects on academic performance (Józsa & Morgan, 2014; Mercader et al.,2017; Mokrova et al., 2013)

H2/S5: Executive Functions skills directly affect academic performance (Foy & Mann, 2013; Cartwright, 2012; Kolkman et al., 2013).

H3/S5: Mastery Motivation directly affects Executive Functions skills (Becker et al., 2019; Hauser-Cram et al., 2014; Pessoa, 2009; Peterson & Welsh, 2014)

H4/S5: Executive function skills mediate the relationship between mastery motivation and academic Performance (Sung & Wickrama, 2018; Rash et al., 2016)

H5/S5: Children with low mastery motivation and high Executive Functions difficulties will have a low academic performance (Józsa & Molnar, 2013).

CHAPTER 4

METHODOLOGY

The chapter has six subsections: Research design, sample and settings, measures, the procedure of data collection, analysis and ethical considerations. Due to the nature of the study, two research designs were adopted, one for the design and development of the FOCUS App to suit the Kenyan context and another for the empirical studies. The sample for the various studies is also described and the study area. A total of six data collection instruments were used across the six studies, and different data analytic strategies were employed in the different studies. Since the study involved children, strict ethical considerations were followed during sampling, data collection, analysis and reporting.

4.1 Research Design

4.1.1 Development of FOCUS app for the Kenyan Context

We followed the Education Design Research Approach to design and develop the FOCUS App. Education Design Research has three main methodological steps that are not linear but cyclical (McKenny & Reeves, 2014). Additionally, this development process also involved cross-cultural adaptation. We, therefore, followed International Test Commission, 2018 and Fischer and Poortinga's (2018) guidelines.

Step 1: Analysis and Exploration; This phase addresses problem identification and analysis. Because EDR is a collaborative methodological framework, researchers, professionals such as ICT experts, curriculum developers, and teachers hold consultative engagements to identify the problem and possible solutions. Usually, this stage also includes a literature review(Wolcott et al., 2019). In addition, the local experts in the identified problem area are consulted, and their opinions and suggestions related to the solutions are discussed. Specifically, needs analysis and contextual analysis are done to identify the possible solution to the problem (McKenny & Reeves, 2014).

Step 2: Design and Construction: This stage aims to create thoughtful ideas and models. The design explores potential solutions, while construction involves the development of prototypes that depict the design ideas. Both design and construction are contextualised to embrace the best learning scenario (Wolcott et al., 2019).

Step 3: Evaluation and Reflection: This stage aims to conduct several pilot and empirical testing to judge the strength and weaknesses of the product. It includes pilot

testing in authentic situations and collecting data using diverse methods such as interviews, surveys, personal observations and learning analytics. The collected data is further analysed to inform reflection of the intervention. The generated data is critically analysed and compared with expected results to inform improvements. As the information is shared among stakeholders, the implementation spreads and contributes to theory understanding (Wolcott et al., 2019).

4.1.2 Research Design of the Empirical Studies

The study adopted a non-experimental longitudinal research design since there is no active independent variable. Study 1 was a systematic literature review that adopted a desktop research design to collect, collate and make deductions from the secondary data. Study 2, 3, 4, 5 and 6 adopted an associational research approach that utilised the quantitative survey methods to collect data to investigate the association between the independent and dependent variables (Gliner et al., 2017). The study has two independent variables, mastery motivation and executive functions, related to the dependent variables of pre-academic skills in preschool and academic performance in grade one.

4.2 Sample and Settings

The study was conducted in the Coast Province of Kenya (Appendix 9). According to the 2019 Census, Kilifi County is estimated to have a population of 1,453,787, with 704,089 males and 749,673 females. The county's dependency ratio stands at 101.45 per cent, indicating there is intense pressure on few people in gainful employment. The main economic activity of this county is Tourism, Agriculture and Fishery. According to the 2019 census, 13.2% of the population left school without completion, and a further 19% never went to school at all (p.15). The total population of children aged between 3 to 5 years is 82,655 males and 81,935 females (Kenya National Bureau of Statistics, 2017). This county was selected because it is one of the counties in Kenya with high poverty indices that make it vulnerable to poor developmental outcomes and other family risk factors (Razza et al., 2015). In addition, the county has an urban population that has a high socio-economic status that can be compared with the rural population. The county has 1071 preschools grouped into either private or public owned schools. The total teacher population in preschool was 3261 by 2018. The teacher-pupil ratio of those employed by the County Government is 1:130, and those employed by parents is 1:50 against the recommended ratio of 1:25.

Moreover, the transition rate from preschool to primary school is 45% indicating that 55% do not proceed to primary school (Institute of Economic Affairs, 2016).

4.2.1 Target Population and Sample

Early childhood education has two classes, preprimary 1 and 2. The population targeted for this study will be all the 1002 preschools in Kilifi County that attend preprimary II and grade 1 pupils. This includes both Public and Private schools. According to the Early Childhood Policy (KICD, 2017), this age category is around five years old and should graduate and join grade 1 in the next calendar year at six years of age.

4.2.2 Sampling Procedures and Sample Size

A list of all schools in the County was obtained from the Director of Early Childhood education at Kilifi. Kilifi County has nine sub-counties; each selected purposively to participate in the study. Schools in the sub-counties were stratified into four strata according to the school type; public rural, public urban, private urban and private rural. From each sub-county, schools were selected using random sampling for each category of schools. Since each sub-district have a different number of schools, these schools were selected proportionately. Simple random sampling was used to select 15 pupils from each school while counterbalancing for gender and age. The students were the unit of analysis. To calculate the minimum number of participants required. With an estimated population of 100,000 participants, a confidence level of 95% and a margin of error of 5%. The minimum sample size required was 384. Using G*Power 3.1.9.4, the sample size was big enough to yield a medium effect size at a power of 80%. To take care of attrition during the study and increase statistical power, it is recommended to have a more significant number of participants (Gliner et al., 2017).

For study one, no samples were required since it was a scoping literature review. A total of 2098 records were scrutinized following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009). Study 2 featured the design and development of the FOCUS app. This study followed the Educational Design research methodology. The first pilot targeted more than 200 students, but only 87 children were successfully assessed due to the pandemic, which made collecting data difficult. After some revisions to the app, the second pilot targeted more than 300 students, but just like the first pilot, all schools were closed after only 52 children had been successfully identified and assessed.

Study 3 sampled 397 preschool children, rated by 11 teachers. The teachers filled the preschool Preschool Dimensions of Motivation Questionnaire 18 to rate the children's mastery motivation. This study aimed to determine the psychometric properties of the newly translated and adapted Preschool Dimensions of Motivation Questionnaire 18. To calculate inter-rater reliability, 50 children were rated by 50 parents who were also randomly selected for the second time. Additionally, from the same sample, 30 children were selected randomly and rated for the second time by the teachers using the English version of Preschool Dimensions of Motivation Questionnaire 18. The second rating by the teachers was used to determine parallel forms reliability of the Preschool Dimensions of Motivation Questionnaire 18.

Study 4 sampled 525 children rated by 25 teachers from 27 different schools. This study aimed to determine the psychometric properties of the CHEXI in the Kenyan context. Study 5, on the other hand, sampled 535 children and examined the contribution of mastery motivation and executive functions to the academic performance of grade 1 children. The teachers filled the Preschool Dimensions of Motivation Questionnaire 18 school version and the CHEXI. The grade 1 children were also examined using Math, English, and standardised Swahili tests. Finally, study 6 sampled 256 children and assessed mastery motivation using the newly developed FOCUS App.

4.3 Measures

To assess children's ability in mastery motivation and executive functions, it is recommended that multiple assessment instruments be used that can be triangulated to corroborate results (Morgan et al., 2019)**.**

4.3.1 Dimensions of Mastery Questionnaire (DMQ 18)

The Preschool DMQ 18 has seven sub-scales (Morgan et al., 2019)(Appendix 3). The first four scales are related to the instrumental(persistence) aspects of mastery motivation, namely:(1) Object/Cognitive persistence scale (five items),e.g.,"Works for along time trying to do something challenging". (2) Gross motor persistence scale (five items),e.g."Tries to do well in physical activities even when they are challenging (or difficult)". (3) Social persistence with adults scale (five items), e.g."Tries to figure out what adults like".(4) Social persistence with children/peers (six items), e.g."Tries hard to make friends with other kids". The subsequent two scales assess expressive/affective aspects of mastery motivation. (5) mastery pleasure measures positive affect after

finishing or while working on a task with five items, e.g., “Gets excited when figures out something”.(6) negative reactions scale has eight items focusing on sadness/shame, e.g., “Seems sad when he or she does not accomplish a goal” and frustration/anger, e.g., “Gets upset when not able to complete a challenging task”. Finally is the general competence scale, with five items, e.g.,“Solves problems quickly”. Since most Kenyan parents cannot comprehend English, the tool was translated to Swahili to fit the Kenyan context, following best practices of translating the DMQ to other languages (Fajrianthi et al., 2020; ITC, 2018).

To compute the cognitive persistence of the child, the five items in the subscale are averaged as follows:(1+14+17+23+29)/5. Averages are calculated for gross motor persistence (3+12+26+36+38)/5; social persistence with adults (8+15+22+33+37)/5; social persistence with children (6+7+25+28+32+35)/6; mastery pleasure(2+11+18+21+30)/5; negative reactions for both frustration and anger (9+13+16+19+5+24+34+39)/8; and finally, general competence (4+10+20+27+31)/5.

4.3.2 Task Motivation Questionnaire

After the children had completed the FOCUS App tasks, each child was interviewed based on the Task Motivation scale for Children (Lerkkanen & Poikkeus, 2006). This scale was developed to measure children's interest and value in the various school subjects based on Eccles et al., 1983. The scale has eight items that target a particular task motivation in a curriculum, e.g., interest in reading or number recognition. We adopted seven items of this scale and applied them to FOCUS tasks; number recognition, letter recognition, number search, letter search, picture memory and card sorting tasks. To introduce the children to the measurement procedure, children were asked about their favourite party or food, e.g., chips and chicken. They were asked how they respond when their best food is presented. We presented a set of five faces (picture of unhappy face 1= I do not like that food; a picture of a happy face = 5 I like that food very much). From this example, we replaced food with each FOCUS task (Appendix 7)

4.3.3 School Performance Test

A standardized test developed and validated by the Kenya National Examination Council in partnership with Global Partnership for Education and World Bank was used to assess the academic performance of grade 1 during the second term (see Appendix 8). All the items were obtained from grade one textbooks approved by the Kenya

Institute of Curriculum Development. The exam tested three subject areas: Math, English, and Kiswahili (or Swahili in English), one of the official national languages in Kenya. In Kiswahili, the test assessed comprehension (12 items), language use (13 items) and writing (10 items). In math, the examination assessed shape identification (4 items), number naming, producing sets (3 items), quantity discrimination (4 items), putting together (addition) (2 items), take away (subtraction) (2 items), mental addition, and measurement (5 items). The English language test assessed dictation (2 items), language use (13 items), writing (10 items), and reading comprehension (10 items). All items got correctly were awarded one mark and zero if not correct. Total marks per subject were converted to a percentage score.

4.3.4 Emotion Observation Score Sheet

This observation sheet (Appendix 5) required an examiner to observe the following. (1) The most intense emotion: positive, neutral or negative during each task level. (2) The intensity of emotions at each task level. a) If the most intense emotion was neutral, the intensity of emotion was noted as 0. b) Positive emotion: 1 = low positive (e.g., closed mouth smile), 2 = moderate positive (e.g., open-mouthed smile), 3 = high positive (e.g., smile and positive vocalization or clapping, excited body); c) Negative emotion: 1 = low negative (e.g., slight frown), 2 = moderately negative (e.g., clearly angry or sad face), 3 = high negative (e.g., angry or sad face and negative vocalization or crying). 3. Persistence was rated as the time the child was focused on trying to do the task. 1 = 0-19%, 2 = 20-39%, 3 = 40-59%, 4 = 60-79%, 5 = 80-100% (Józsa et al., 2017, p. 114).

4.3.5 Childhood Executive Functioning Inventory (CHEXI)

The CHEXI (Thorell et al., 2010) was developed based on Barkley's (1997) hybrid model that identified working memory, inhibition and regulation as the major deficits in children with ADHD. The CHEXI is a 24-item questionnaire that is simpler to fill and freely available online (https://chexi.se/onewebmedia/CHEXI_ENG.pdf.) It has four priori subscales: working memory (11 items), e.g.,"Has difficulty understanding verbal instructions unless he/she is also shown how to do something, inhibition" (6 items), e.g., "Has difficulty holding back his/her activity despite being told to do so, planning" (4 items), e.g., "Has difficulty with task or activities that involve several steps, and regulation" (5 items), e.g., "Seldom seems to be able to motivate him-/herself to do something that he/she does not want to do". For each statement, the child

is rated from 1- definitely not true to 5 true. When scoring the CHEXI, subscale 1, working memory is represented by the total scores of items 1,3,6,7,9,19,21, 23,24; subscale 2, planning 12,14,17,20; subscale 3 regulation, 2,4,8,11,15 and subscale 4, inhibition 5,10,13,16,18, 22. The four subscales factor analysis in kindergarten children identified two categories, working memory (working memory and planning) and inhibition (inhibition and regulation).

4.4 Procedures for Data Collection

The researcher sought research authorisation from IRB at the University of Szeged, Hungary and Kenya's National Council for Science, Technology and Innovation (NACOSTI). Before any data collection, the participants were briefed on the purpose of the study and their consent sought. Participants were requested to participate in the study voluntarily and are free to withdraw at any stage. On behalf of children, parents were requested to sign the consent forms. During data collection, teachers and parents rated the children using the Kiswahili or English version of the pre-school DMQ-18. After this, all the children were provided with tablets installed with the FOCUS app. The session began with the researcher introducing himself and later introducing the children to the tablets. Children were shown examples of phones, tablets, and laptops to ensure they were familiar with these gadgets. A warm-up session followed before data collection. When kids are comfortable with the narrator's little puppy', the child is set aside for the experiment. The test administrator later filled the login screen with user identification and password. Each child was allocated an Identification number, birth year and gender. To identify whether the child will take the tasks in English or Kiswahili, we asked the class teacher or the student to give us the language they commonly use during instruction. After setting these details, the child could proceed with the experiment. As children were proceeding with the experiments, the examiners rated the children’s persistence and emotional reactions when taking the mastery motivation and executive function tasks on the rating sheet. The video recording was also supported by providing images of student persistence during the entire experiment. The second data set was collected when the children were in Grade 1 in the following year. An performance test on literacy and numeracy was also administered in grade one. Table 2 displays the structure of activities we carried out during the course of the studies.

Table 2

Timeline and Research Activities

Timeline	Research Activities	Instruments	Samples
September – December 2018	Identification and refinement of the research topic. Develop a Research Plan and presentation Request Ethical approval from the IRB(Szeged) Construction of tools, i.e. DMQ 18 and FOCUS to Kiswahili		
February – August 2019	Study 1: Scoping Literature Review and compilation Literature review in grey materials Tools approval A pilot study in Kenya(Study 1) Seminar and conferences	DMQ 18(Morgan et al. 2019) Computer-Based Assessment (FOCUS)(Józsa et al., 2017)	Preschool teachers N=397(DMQ) N=89(CBA) N=50(parents)
September-December 2019	Review tools and adaptation Analyse pilot data Finalise pilot 1 data analysis Seminar and conferences	DMQ 18 Computer-Based Assessment (FOCUS)	
February-June, 2020	Pilot 2 - data collection (first iteration after revision)	Computer Based Assessment (FOCUS)	N = 52
September-December, 2020	Analyse Pilot 2 data Manuscript preparation Seminar and conferences		
February-June 2021	Phase 2 Data collection (study 4, 5 and 6) Seminar and conferences	DMQ 18 Computer-Based Assessment (FOCUS	N=535(DMQ) N=275(CBA)
September-December 2021	Analysis of data Manuscripts Thesis writing		
February-June 2022	Iteration of FOCUS revisions Home defence Public defence		

4.5 Data Analysis

The Empirical studies adopted the quantitative analysis of data. In every study, data analysis is described in the data analytic plan section. In addition, qualitative analysis, specifically interviews and focus group discussions, were employed during the needs analysis.

4.6 Ethical Consideration

Before data collection, the researcher sought ethical approval from the University of Szeged, IRB and the National Council for Science, Technology and Innovation (NACOSTI) in Kenya (Appendix 12). Research assistants were trained on research ethics to ensure all ethical standards were upheld. Since the data collection involved children, they were required to assent while written consent came from parents and teachers of all participants before data collection (Appendix 1). The FOCUS app is designed as game-like and exciting for children to ensure that data collection is enjoyable for the children. Children who felt uncomfortable were free to exit at any stage they wanted. The researcher ensured there was no harm to the participants, whether physical, psychological, economic or social, that will affect the participants. Participants were also selected randomly to ensure there was an equal chance of participating in the study. Before any activity, participants were provided with complete information regarding the study's nature, purpose, procedure and benefits in a language they understood. The participants were reminded that the research was voluntary and that they could withdraw at whatever study point. Efforts were enforced to safeguard the participants' data through passwords, keys, and locks. Secret codes were also used so that the participant's information was protected. All efforts to maximise benefits and reduce all forms of risks were pursued. Lastly, debriefing was done to ensure all fears, worries and concerns were answered exhaustively.

CHAPTER 5

DEVELOPMENT OF TABLET-BASED ASSESSMENT OF SCHOOL READINESS

This chapter has three subsections that followed the Education Design Research Approach to develop the FOCUS App to suit Kenya. As described in the methodology section, the subsections are Analysis and Exploration, Design and Construction, and Evaluation and Reflection. Before delving into the main subsections, first, an introduction is provided to help the reader understand the Education Design Research framework and why it was helpful in this development process. In addition, two studies were developed during the development and implementation process of the FOCUS app; a systematic literature review at the needs analysis stage and two pilot studies at the evaluation stage.

5.1 What is Education Design Research Approach?

EDR (van Akker et al., 2006), also known as Design-Based Research (Design-Based Research Collective, 2003), is a methodological framework to develop a product to improve educational practice and contribute to a further understanding of educational theory. Thus, EDR has characteristics between a method and a methodology (Bakker, 2018). For this reason, other theoretical, empirical, and established scientific methods can be used within EDR without restrictions (Reinmann, 2020). By definition, EDR is

> "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories (Wang & Hannafin, 2005, p. 6).

EDR has several universal characteristics: authentic, contextually aware, collaborative, theoretically focused, methodologically diverse, iterative, practical and operational(Table 3) (McKenny & Reeves, 2014; Wolcott et al., 2019). The theoretical outputs from EDR sometimes can be prescriptive, often referred to as design principles. Apart from theoretical contributions, EDR provides practical contributions to solve real authentic problems in education. EDR interventions include educational products (e.g.,a digital tool to assess school readiness and learning materials), policies (e.g.,school evaluation protocols), processes (collection of teaching activities) and programs (e.g.,teacher professional development) (McKenny and Reeves, 2014). EDR is also

helpful in developing digital tools to assess learning progress, infrastructure to support research-based learning, and infographics to assess complex education issues (Reinmann, 2018). Several models have been used in EDR. The most popular is the generic model by McKenney & Reeves (2014; 2018), which has three interrelated stages; (a) analysis and exploration; (b) design and construction; (c) evaluation and reflection; (McKenney & Reeves, 2014;2019). This study adopted this approach by McKenny and her colleague. Recently, Reinmann, 2020 has proposed a new dynamic and holistic model of EDR that has five stages: Conception, Design, Development, Testing and Analysis.

Table 3

Characteristics of Education Design Research Applied in the Current Study

Characteristic	Current study application
Authentic	A school readiness assessment is a daily activity in every school as they recruit and promote children from preschool to school
Contextually aware	Aware of other initiatives of school readiness assessment such as the Kenya School Readiness Assessment Test and child interviews were addressed, including teacher and student needs
Collaborative	We engaged different professionals; programmers, system administrators, internet service providers, preschool teachers, children, researchers, sound producers, language experts, curriculum developers
Theoretically focused	Theories of mastery motivation, executive functions, and school readiness were the focus. In the development of the app, theories of Game-based assessment and learning analytics were applied
Methodologically diverse	Qualitative data-interviews focus groups, observations, and video records; Quantitative- surveys, learning analytics, observation data
Iterative	After every pilot, we revise and fix challenges; 4 iterative cycles of revision
Practical	Lack of programmers, Time and budget constraints affect the app development and implementation
Operational	We developed and expanded menus for more languages so that the app could fit other diverse countries; US, Hungary, Kenya and Israel. In addition, plans are underway to develop a Chinese version.

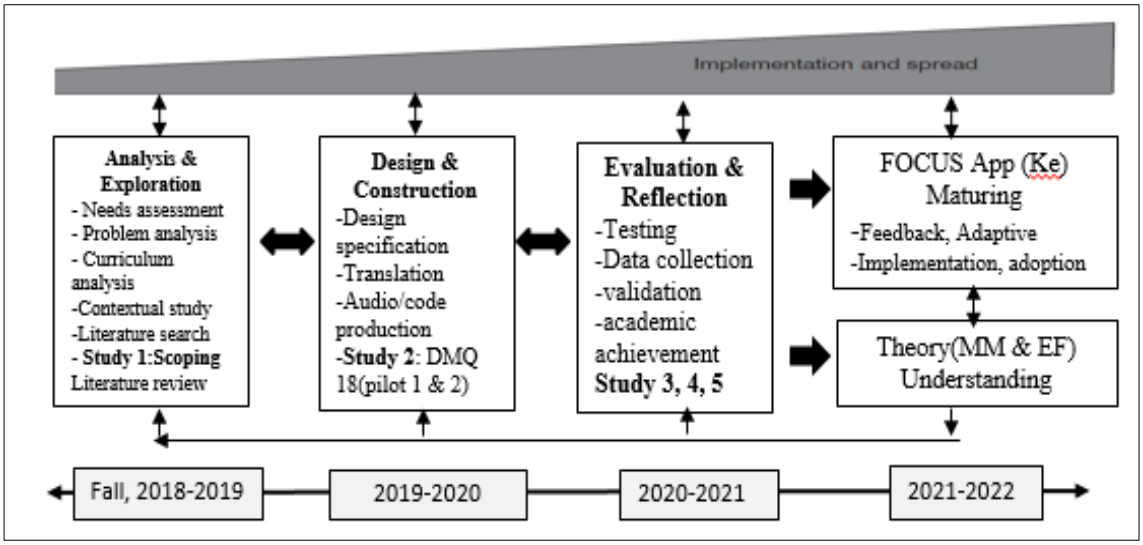
Source. Adapted from McKenny & Reeves, 2014 and Wolcott et al., 2019

Rationale for Educational Design Research as a Framework for this Study

Education Design Research (EDR) is a robust framework in educational research because it simultaneously or synergistically contributes to both theory and practice. To achieve this, EDR fulfils three crucial goals: (a) builds the foundation of an intervention (product), e.g., the FOCUS app that is meant for actual use but not hypothetical products; (b) it is based on scientific inquiry; (c) the testing of the empirical results of the products advances the theory, e.g., theory of mastery motivation and executive functions (McKenny & Reeves, 2014). Secondly, studies with a development/design aspect have the requirement of social responsibility to the practitioners to solve real challenges in education (e.g., enhance school readiness in Kenya) and develop design principles (theories) from products designed (McKenney & Reeves, 2018)(Figure 2). Thirdly, educational products' design and development processes are not linear, and several cyclical iterative stages require revision before proceeding to the next stage. These iterative cycles are best addressed in EDR. Finally, EDR accommodates theoretical, empirical and other established scientific methods (Reimann, 2020). This makes it very suitable for internal users (learners and teachers), internal clients(schools, districts), external educational researchers and professionals (McKenny & Reeves, 2018).

Figure 2

Methodological Framework for the Development of FOCUS App for Kenya



Source: Adapted from McKenny & Reeves, 2014, p. 77
Note: DMQ 18 -Preschool Dimension of Mastery Questionnaire; FOCUS-Finding Out Children Unique Strength ; MM-Mastery Motivation; EF-Executive Functions

5.2 Step 1: Analysis and Exploration

The main activities of this phase are to specify the educational problem at hand, its context, and the stakeholders involved (McKenney & Reeves, 2014). In the context of cross-cultural adaptation, these cover the first five steps in the process of planning proposed by Fischer and Poortinga (2018). In the first instance, we identified the problem to be addressed. Studies carried out by Uwezo Kenya from 2009 to 2015 showed that the learning levels are still low. For example, in 2015, only 3 out of 10 grade three pupils could do grade two work and 8 out of 100 grade eight pupils could not do grade two work (Uwezo, 2016). This has elicited several meetings and discussions to address the assessment of preschool to school transition. The Kenyan educational system acknowledges the need for and uses school readiness assessments (Republic of Kenya, 2017). Unfortunately, although Approaches to Learning are acknowledged as essential to school success, currently, there is no attempt to enhance the learner's motivation and executive functions in the pre-primary curriculum. This suggests a need to enhance the Kenyan curriculum to address these school readiness domains and accurately measure whether or not there is growth in the domains. This again supported the potential benefit of developing a tool to assess Approaches to Learning for Kenyan students. We, therefore, composed a multi-disciplinary team of developmental psychologists, curriculum developers, Kiswahili and English language experts, teachers, ICT professionals, and other stakeholders. These experts participated in our stakeholder meetings at different stages. We also carried out document analysis of preschool teachers to determine if teachers also assessed Approaches to Learning during the transition to grade 1. Our effort to get documentary evidence of the Approaches to Learning assessment was not possible, signifying poor record keeping. Thus, the areas of Approaches to Learning are not currently included in preschool to school readiness assessments in Kenya and require urgent intervention. Therefore, in the third stage, we identified our psychological construct as two components of Approaches to Learning as our target: mastery motivation and executive functions. We also carried out interviews following a guide with preschool teachers who attended school-based training in one of the national universities in the Coast region. This was followed by another set of interviews with County Education officers, parents, and curriculum experts to establish how school readiness is assessed in preschool and what interventions are taken to remediate any deficits. Results showed that teachers rarely directly assess or report on the child's Approaches to Learning. One teacher reported to

us during the interviews, "We train the children, but interviews to join grade one is done by grade 1 teachers, who never taught them and they do not share with us the questions nor the results". A further interview with the County Early Childhood officer revealed that they are yet to be trained on using the new Kenya School Readiness Test, indicating that most teachers are not competent in filling and interpreting the tool.

Additionally, the tool does not have a section on motivation or executive functions; thus, assessments are basically on academic skills (see Appendix 2). Apart from stakeholder meetings to discuss how Approaches to Learning are assessed and their context variables, we also carried out an intensive literature review of school readiness domains. From the literature, we anchored our study on the theory of approaches to learning (Kagan et al., 1995). From stakeholder meetings and literature searches, we agreed that a form of direct assessment that could be administered without the need for intensive training of examiners is a narrated, self-administered, computer tablet-based method. However, we are not aware of any tablet-based assessment of both mastery motivation and executive functions used in Kenya. As a first step, we agreed to carry out an intensive literature review to identify how other researchers have developed assessments for school readiness domains and identify an appropriate app that can be adapted to assess school readiness to fit Kenya. We, therefore, conducted a scoping literature review to identify the available game-based assessment of school readiness domains and the extent of the research gap (see study 1 in the empirical studies section).

The review identified only one application used to assess Approaches to Learning domains, mastery motivation and pre-academic skills, the FOCUS (Finding Out Children Unique Strengths) App. We agreed to develop further the app assessing mastery motivation and executive functions for the Kenyan context. We agreed to build an easy-to-use app to share, assess more than one school domain, and adopt an evidence-centred design to fill this gap.

5.3 Step 2: Design and Construction of the FOCUS App

The aims of this phase are first to adopt a systematic procedure that will generate solution(s) to the identified problem (design) and chart clarifications as design principles that can be used in the future (Van den Akker et al., 2013). Next, construction entails the creation of prototypes that exemplify these design ideas. This phase is similar to the sixth step of the planning process of "operationalizing the theoretical predictions"

(Fischer & Poortinga, 2018, p. 704). In order to inform the design and construction, we carried out a review of the literature on similar apps used to assess the school readiness domain (Amukune et al., 2021). However, for assessing mastery motivation and executive functions as components of Approaches to Learning, we only got one app - the FOCUS app, initially designed for Hungarian and American cultures (Józsa et al., 2017).

5.3.1 First Iterative Cycle - Face to Face Pilot Testing

The first iterative cycle of FOCUS app design was a face-to-face pilot study. The number and letter search tasks were printed on A4 pieces of paper, and the table took the form of a computer screen. The letters and numbers were created in increasing levels from level 1 to 8. These tasks were based on moderately challenging tasks that were neither too easy nor too difficult for the child of that age (Morgan et al. 1992). Children searched for the correct number and letter on the table and then placed the correct cards on top of the letter based on the instructions they received from the examiner. The table surface was assumed to be the computer screen. Each child was given 2 minutes to undertake the task until they had completed it or gave up on the hard tasks at level 8. When the number or letters were placed on the correct discs, it was registered as correct, if not as an error. The time spent on these tasks was registered in seconds. After the tasks, the children's emotions were assessed using a task motivation questionnaire, which stylized images of child faces when (angry, sad, neutral and happy). However, children did not reliably reflect their emotions. After the pilot, the combination of letters and numbers was changed to increase the difficulty levels.

5.3.2 Second Iterative Cycle – Online Computer-Based Tasks

After the results of face to face testing, the levels were reduced from 8 to 4 due to time constraints. The levels were level 1- easy, two moderating challenging tasks and one hard task. These task images were drawn using Gimp and MS PowerPoint and integrated into the computer program. Based on face to face results, the computer tasks increased in levels of difficulty from easy for a 3-year-old to difficult for 8-year-olds. The search for numbers and letters was in an array of cards that measured the child's persistence in the moderately challenging task. In addition, other tasks were added, namely, pre-academic skills of number and letter recognition and executive function tasks. Together these tasks provide a good measure of school readiness (Józsa et al., 2017; Zelazo et al., 2016). This version was web-based, developed on the .net platform

and collected data on pre-academic skills, mastery motivation and executive functions, which was online based. This version was in English and Hungarian only.

5.3.3 Third Iterative Cycle - Offline Android Tablet-Based Tasks

Since not all schools are connected to reliable and fast internet connectivity, there was the need to develop an offline version that could be uploaded to the server later or keep the data within the collecting devices. Therefore, the second iterative was released in 2017, built on the android platform. This version was tablet-based and recorded a video of the child's facial expression as the child concentrated on the tasks. The video recording enables the assessment of participants' focus of attention and emotional expressions (Józsa et al., 2017). However, the size of the video images is overwhelmingly huge. This has created storage challenges on the tablet and the server. This version was in English, Hungarian and Hebrew.

However, the first and second iterative versions had challenges. First, data conversion from the app required an external converter software that required a different package separate from the app to be installed. This package was sensitive to how the files were stored on the device. Second, although the app captures video images, they are vast and difficult to read due to storage space. Second, session two assessed executive functions. Despite the participants undertaking all the tasks, there were challenges in successfully retrieving all the data. Therefore, there was a need to reconstruct the app to fix data conversion and storage bugs. Third, the app is only available in three languages; Hungarian, English and Hebrew. Therefore, adding a module for Swahili and English with a Kenyan accent became essential. Additionally, all the other languages were presented in different modules. However, it was agreed that all other languages be brought into one app so that researchers can have free will to choose the language of their choice.

5.3.4 FOCUS Tasks in the Android-Based Version

FOCUS evaluates three competencies: pre-academic competencies, mastery motivation and executive functions. To measure these competencies, FOCUS has a total of seven tasks. Tasks 1 and 2 assess the accuracy of recognition of numbers and letters, the two pre-academic skills measured. Tasks 3-5 are letter and number search tasks designed to assess mastery motivation, operationalized as the child's persistence during moderately challenging tasks. The time taken while matching moderately

challenging letter and number matching tasks was taken as mastery motivation. Moderately challenging tasks are activities that are neither too difficult nor too easy for a child at that particular age. This approach to measuring mastery motivation is based on Morgan et al. (1992), who developed a procedure for separating a child's ability from motivation. Tasks 6 and 7 are tasks primarily designed to assess executive functions but which can also provide mastery motivation measures. For example, one is a picture memory task, in which the child needs to match "cards" that are "upside-down" so that children cannot see the picture on them. Thus, children must match them by remembering where the exact picture was located.

Persistent on this task also provides another measure of mastery motivation. The other task, called the Size-Shape-Color Game, is designed to measure cognitive flexibility and inhibitory control. The Size-Shape-Color Game is a modified version of the Dimensional Change Card Sort task (Zelazo, 2006). The Size-Shape-Color game involves having the child sort "cards" with pictures on them into "baskets" by considering a particular sorting dimension, such as colour. In the original Dimensional Change Card Sort, two dimensions varied, shape and colour, and the child needed to keep in mind one of these dimensions when sorting. Then, the child needed to "switch" and sort the same cards using the other dimension. It, therefore, required the child to "cognitively switch," flexibly, from one way of sorting the cards to another and to inhibit their learned tendency to sort on the prior dimension.

In the Size-Shape-Color game, children must switch between multiple dimensions at higher levels, including size, shape, colour, number, opposite size, opposite shape, and opposite colour. At the highest levels, they need to change dimensions frequently, often after only one or two sorts on a particular dimension, rather than consistently sorting on one or the other dimension. As a result, the tasks get pretty difficult, enabling the task to be appropriate for even competent elementary school-aged children. *The Size-Shape-Color Game,* modified from *Dimensional Change Card Sort* task (DCCS: Zelazo, 2006), differs from other DCCS that adopt reaction time to depict difficulty at higher levels. Tasks 3 to 7 are measures of Approaches to Learning since they provide for non-academic attributes of the learner, such as motivation, engagement and focus, which are significant in academic success in a classroom setting. Since data are collected individually by the tablet as each child completes the tasks, the results on each school readiness domain can be profiled for each child. This will allow for individualised remediation and enrichment efforts by the teacher and parent (Barrett et

al., 2017). Based on the literature, the tasks assessed, i.e. pre-academic skills, mastery motivation and executive functions, form a good measure of school readiness (Józsa & Barrett, 2017; Zelazo, Blair, & Willoughby, 2016).

5.3.5 Strengths and Limitations of the FOCUS app as a School Readiness Assessment Tool

Firstly, this app assesses more than one school readiness domain of interest: pre-academic skills, mastery motivation and executive functions. Many tools we explored during the literature review only measured one aspect of school readiness. Thus creating a "silo" effect for the other variables. Ability to assess more domains has been regarded as an indicator of a good school readiness assessment tool (Sall et al., 2001). Secondly, the FOCUS app has adopted the Evidence Centred Design, which provides evidence for tasks undertaken by children. These tasks are easy to manipulate and revise while observing the outcome on the learner. Thirdly, it is game-based, thus very easy for the children and automates the process of data collection using a narrator that gives instructions. The animated narrator, a little bear or puppy, is loved by children and provides instructions on how tasks will be carried out. Furthermore, since it is tablet-based, the assessment can be done inside or outside class and even at home. This increases the ecological validity of the assessment (Obradovic et al., 2018).

Moreover, the tasks are individualised but not group tasks. This increases the ability of the app to offer individualised interventions, one of our objectives of enhancing school readiness in Kenya. Fourthly, it was easier to get the source code since a research group initially designed the app from the University of Szeged. Unlike other tools that have adopted *the Dimensional Change Card Sort task (DCCS: Zelazo, 2006),* the FOCUS app does not use reaction time to measure difficulty at higher levels. Additionally, the FOCUS app has another advantage of simultaneously using the same tasks to collect data on executive functions, mastery motivation and competence. For example, tasks 3-5 on number and letter search can also assess inhibitory control in that learners with lower inhibitory control touch incorrect items. Moreover, accomplishing tasks 6 and 7 requires a lot of persistent and focused attention, which is another measure of mastery motivation (Barrett et al., 2017).

Despite these advantages, FOCUS has some limitations that need to be improved. The FOCUS app allocates tasks according to age rather than the child's competencies. Adaptability based on age is good, but it is much better based on

competencies, which help to reduce floor and ceiling effects. As mentioned elsewhere, the modules need to be brought together to give the researcher a more extensive choice of language depending on the needs of the children. More languages and diversity need to be added to suit children of other continents. The other iterative cycles suffered data losses in session two, which must be addressed. In addition, a feedback module to give quick results to children can be very motivating.

Further, the FOCUS app only assesses cognitive persistence but not other mastery motivation factors such as social persistence with children or adults and gross motor persistence. The assessment of mastery motivation is based on the moderately challenging tasks provided to the child. However, it is not easy to find equally challenging tasks for all children in the same way. Additionally, the learner does not have an opportunity to choose tasks as they wish; instead, the app provides the task, which reduces ecological validity (Barrett & Morgan, 2018).

5.4 Construction of FOCUS app for Kenyan Context

This is the fourth iterative cycle in the development of the FOCUS app. This phase adopts a systematic procedure to generate solution(s) to the identified problem (design) in the Kenyan context. To construct FOCUS to suit the Kenyan context, we first analysed the curriculum content for preschool in Kenya to examine how the content of the FOCUS app is or is not relevant to current pre-primary educational practices.

5.4.1 Curriculum Analysis

Two approaches were adopted, forward and backward curriculum analysis (Holtsch et al., 2016). In the forward analysis, we investigated whether the content of FOCUS was found in Kenyan Curriculum. In the backward analysis, we analysed how the Kenyan preschool curriculum was represented in FOCUS. The curriculum explored were the preschool curriculum designs (KICD, 2017a) and grades 1 to 3 in maths and languages(KICD, 2017b). Results showed that all tasks are covered in the curriculum. However, two tasks were challenging for preschoolers, i.e. items 14 and 15 in number recognition but manageable to grades 1 to 3 (Table 4). The backward analysis identified several topics in the curriculum that were not represented in the FOCUS app especially writing and speaking skills.

Table 4

FOCUS Tasks Based on the Kenyan Pre-primary and Elementary Grade Curriculum

Task	Content coverage	Level of difficulty
First Session: Pre-Academic and Mastery Motivation		
1 or 2 Number recognition	Preprimary 1 & 2; Classification, reading, number and measurement, listening skills (Nos 1-9 and their combination as tens and hundreds)	Easy in English but difficult in Kiswahili for PP1
2 or 1 Alphabet recognition	Preprimary 1 & 2: Classification, reading, letter and measurement, listening skills (letters A to Z in small and capital letters and sounds a to z)	Easy in English but difficult in Kiswahili for PP1
3 or 4 Number Search	Preprimary 1 & 2, Grade 1,2,3: Classification, reading, letter and measurement, listening skills (combination of two and three numbers increasing in difficulty)	Easy in English but difficult in Kiswahili for PP1
4 or 3 Letter search part 1	Preprimary 1 & 2, Grade 1,2,3; Classification, reading, letter and measurement, listening skills(combination of two and three letters)	Easy for PP2 and difficult for pp1
5 Letter search part 2	Preprimary 1 & 2, Grade 1,2,3(combination of two and three letters increasing in difficulty)	Easy for PP2 and difficult for pp1
Second Session: Executive Functions		
6 or 7 Picture memory	Pre-primary 1 & 2, Grade 1,2,3: Classification, reading, letter and measurement, listening skills, geometry (shapes and objects in different shapes and colours)	Easy to difficult
7 or 6 Dimensional change card sort	Pre-primary 1, 2, Grade 1, 2,3. Classification, reading, letter and measurement, listening skills, colour (shapes and objects in different shapes and colours)	Difficult for PP1 in Kiswahili

Note. Age for Pre-primary 1 is 4 years, pre-primary 2, 5 years, Grade 1, 6 years, grade 2 7years and grade 3 8 years old

5.4.2 Content Revision to Suit Kenya

The team also analysed the narration in the original American English version to see if it would be suitable for the Kenyan context. We randomly recruited five children and three teachers from three pre-schools and gave them the audio content from the original FOCUS to listen to. Three children came from a poor background in a rural setting, and two came from a private school in an urban setting. All the children spoke Kiswahili at home and school with little English and also had very little exposure to tablets. Before the exercise began, children were shown examples of phones, tablets, and laptops to ensure they were familiar with these gadgets. When the child is comfortable with the tablet and the narrator's little puppy', the child is set aside for the exercise. Understandability was judged based on the ability of the learners to undertake the task as per the instructions of the audio (Kotani et al., 2014). All the research team members agreed that the American English accent would be challenging to understand for Kenyan preschoolers. We, therefore, decided to use two versions of the narration, Swahili and English versions, both narrated by a female teacher with a Kenyan accent.

The team also replaced Little Bear, the narrator, with "Little Puppy" to achieve cultural equivalence. The bear is an animal that is unfamiliar to Kenyan culture and which has no simple Swahili name for the children. This was done to suit the Kenyan culture better and avoid bias caused by cultural-based specifics (El Hassan & Jamal, 2005). We also replaced "bunny" with "rabbit," which is a more familiar English terminology in Kenya. We followed International Testing Commission guidelines (Gregoire, 2018) to translate the English version of the FOCUS app to Swahili and later back-translated it to English. The back-translated version was compared with the original English version to maintain originality to achieve language and functional equivalence. Furthermore, since the narrator provides instructions to be undertaken by the child in the same way to all the children, the influence of different interpretations is reduced (Peña, 2007).

5.4.3 FOCUS App Source Code Revision

FOCUS app is an in-house software developed using Java programming language. We used Android Studio 2019 to review the source code (Figure 3). Images were developed and edited using Gimp Software. We identified a female of Kenyan origin to narrate the scripts in a professional studio for audio recording. The audio recordings were edited using Audacity, a free open-access software. After the recording,

we edited the audio to ensure they were of the right pitch and later gave each audio file a unique identification name. This ensured that the audio could be recalled and connected to the narrator, the little puppy, to provide the instructions during the computer-based tasks. Since FOCUS is built to run on android devices, the device must support android, or the user can install an emulator on non-android devices. The data is encoded into a database saved in the device and read using a converter developed using C#. Alternatively, the data is uploaded to a server and converted by a background program like python.

Figure 3

Screenshot of the Android Studio used to edit the FOCUS App code

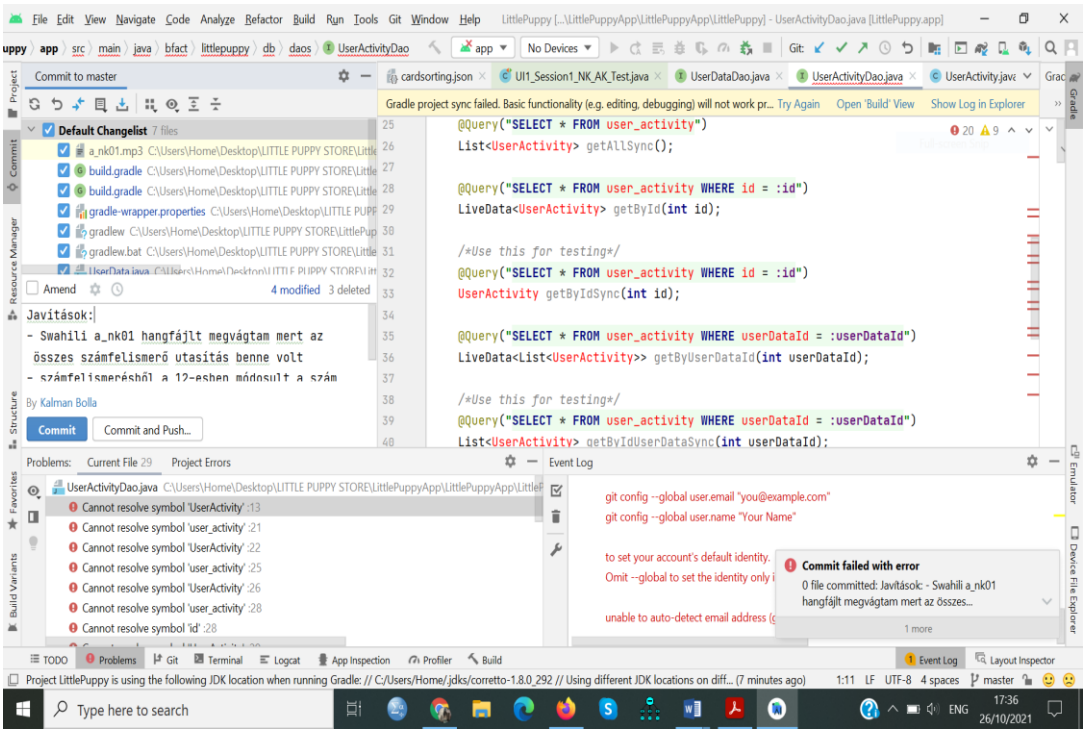
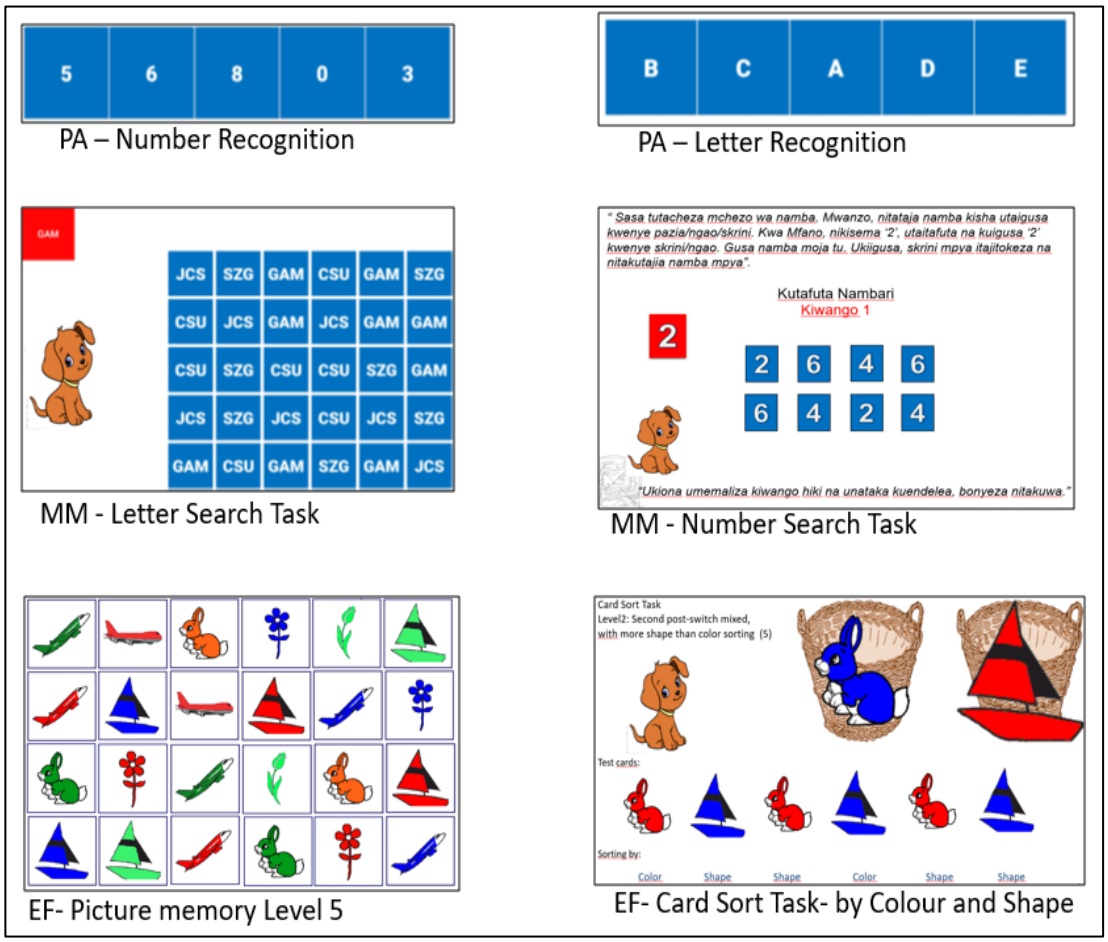


Figure 4 shows one of the screenshots of the newly constructed FOCUS app in Swahili to fit the Kenyan context. The Kenyan version is still on android but with newer advanced Java source code and android platform. In addition, two additional languages have been added to the language menu: Swahili and English, with a Kenyan accent.

Figure 4

Screenshot of the 7 FOCUS App Tasks in Kiswahili.



Note: A little puppy has replaced the original little bear, and the narration is in Swahili

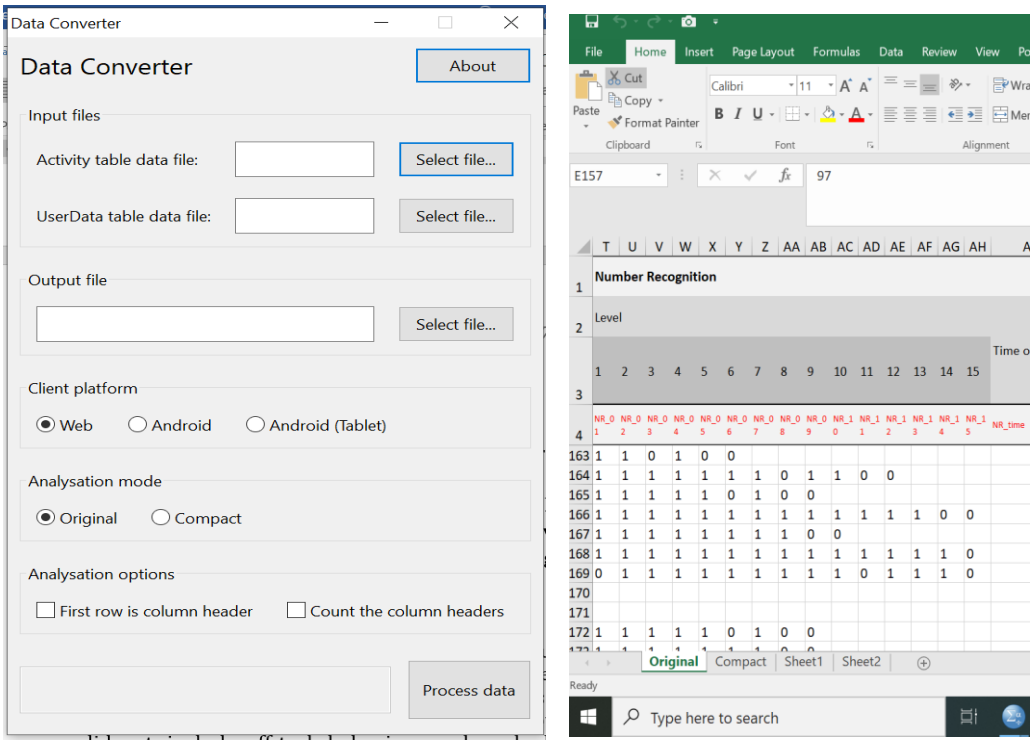
5.4.4 Procedure for data conversion from the tablet-based tasks

FOCUS App saves all the tasks 1 to 7 in the device in a folder as SQL database, User and Activity files. A converter specifically designed for this task is used to retrieve these files. The converter is built using GNU C/C++ compiler/programming languages. The first step of data conversion is to identify the folder that has the SQL database. This folder could be located in the server if the online file storage was prompted or in the device's storage drive. First, however, the converter needs to convert the computer log files to a human-readable form. The conversion process involves two steps. First, select the activity table data file. Then select the user activity table then create a filename for the output file (figure 5). Finally, process the data into a .txt file. In the DataConverter folder, you can find a file: Dataset_Scheme_180720.xlsm. This is the file that imports the Data Converter's output (.txt file). Open the .xlsm file. Upon loading, you will be

requested to enable editing of the file, enable data connections or content and also you might have enabled macros.

The spreadsheet has two worksheets: Original and Compact (Figure 5). They both have an "Import Data" button in cell A1. Clicking on the button, you have to select the corresponding output file (.txt) from Data Converter. Then, use the "Save As" function in Excel to save it to a different workbook. This does not have to be a .xlsm file, and it can be a simple .xlsx file too. The important thing is that you do not overwrite the empty Dataset_Scheme_180720.xlsm file after importing data. This is because if you have multiple datasets (in the case of Android tablets), you might not want to save all the imports as a separate Excel file but copy the lines over to an already existing dataset. So if you have multiple data to import, you have to close the .xlsm file without saving it and open it again between each import.

Figure 5
Screenshot of the data converter and the output file in Ms-Excel.

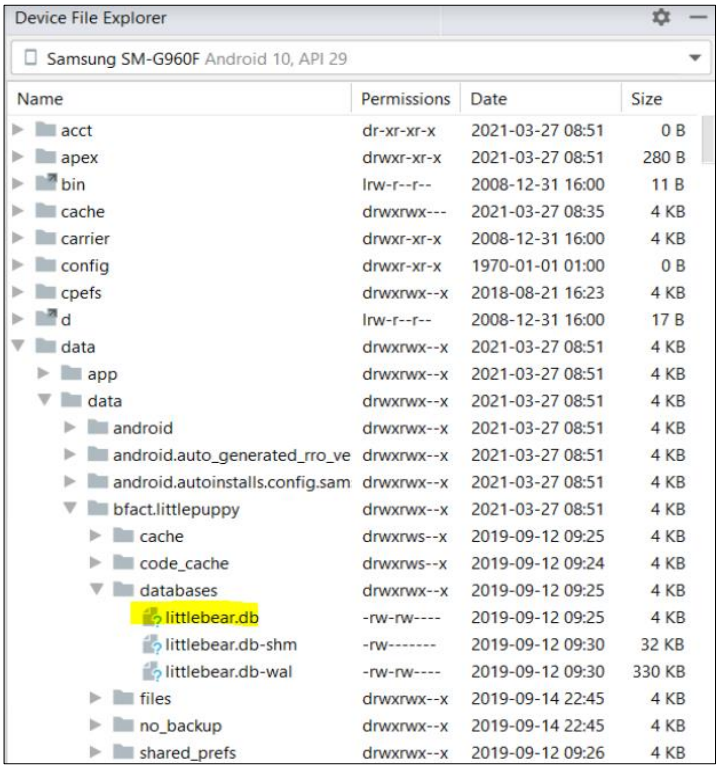


Note. The three steps and client platform. The analysis mode matches the excel output.

Another alternative is to connect the Android device to the developer's computer; Android Studio uses Device Explorer (right side of IDE) to browse data on the connected device, as shown in Figure 6.

Figure 6

FOCUS App data retrieval from the device explorer option



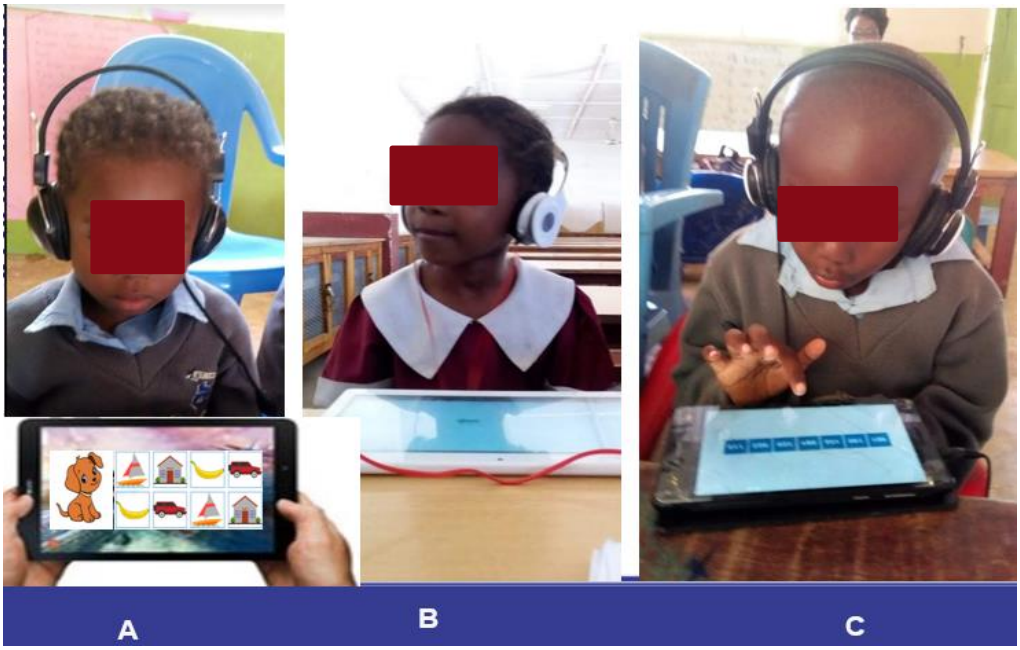
5.4.5 Administering FOCUS app tasks

The examiner locates a comfortable room and quiet for the children and then informs the children that „we are going to play a game on the tablet”(figure 11). Later the examiner fills in the details of the children, date of birth, gender and anonymous name. The app is divided into sessions one and two that can be administered in one day or on different days. Session one assesses pre-academic skills(Task 1-2) and mastery motivation (task 3-5) and session two (task 6-7). In tasks 1 and 2, if the student fails the first two items consecutively, the app jumps to the second task.

Similarly, if the child does not get the first two items correctly, the app moves to task three. For example, the game automatically jumps to letter recognition if the child gets two tasks wrong during number recognition. The rest of the items are skipped assuming the child has very little knowledge of the task. This helps to lower anxiety and frustration (Dockterman et al., 2020). Before each task, training is provided. Then, touching the little bear starts the gamelike tasks. Each session takes approximately 20 to 30 minutes. The app can record videos to assess when the child is not focused on the tasks. For example, in Figure 7, image B shows a child who is not concentrating on the tasks. Similar information was also captured using an Emotion observation questionnaire. The shape of the mouth, smiling, sad or crying were also captured using the emotion observation questionnaire. Since the computer tablet administers the tasks and collects the required data for analyses, the teacher is relieved of adaptive test administration and data collection.

Figure 7

Preschool children in Kenya during School Readiness Assessment



Note: Picture A shows the child-focused on the task; Picture B shows the child is not persistent and focuses on other activities outside the FOCUS app tasks. The shape of the mouth also shows she is smiling, an indicator that the task is easy. Conversely, in pictures A and B, the shape of the mouth shows they are sad, depicting the task as challenging.

5.5 Evaluation and Reflection

This phase entails data collection, data checking, and analysis (Fischer & Poortinga, 2018). After the design and development were complete, we carried out several tests from January 2020 to spring 2021. We first tried the FOCUS app with a small subsample of 15 children and three IT and system administrator experts. The aim was to test the applicability of the app in authentic tasks. Teachers were also allowed to play the game and provide feedback. After the child had completed the assessment, they were allowed to fill out a task motivation questionnaire (Lerkkanen & Poikkeus, 2006) to explore their perception of the FOCUS tasks as described in the method section.

Several errors were identified and revised; for example, "bonyeza", which means to click in Kiswahili, was revised to "*gusa*" for touch. In addition, the names of colours in Kiswahili were also challenging for preschool kids since it was taught for the first time in elementary school. Blue color is "*samawati*" in Kiswahili. Therefore, for conformity with the familiar, "blue" was also adopted in Kiswahili and green, "*kijani kibichi*", in Kiswahili. After the corrections were complete, two empirical longitudinal studies (study 2a and b) were done to evaluate the applicability of the FOCUS App in the Kenyan context. The two studies are presented in the next chapter.

CHAPTER 6

EMPIRICAL STUDIES

As the first step in the EDR framework, we conducted a thorough analysis and Exploration to establish the gap in the literature on mastery motivation, executive functions and assessment of school readiness domains. Study 1 was an empirical scoping literature to establish the extend of the gap of game-based assessment of school readiness domains. This study revealed that, there was only one app that assessed preacademic skills, mastery motivation and executive functions. We adapted this app and developed it further to fit Kenyan context. After the development, we dedicated two longitudinal studies i.e 2a and b to evaluate the suitability of the newly developed app. To assess mastery motivation using ratings, we adapted the Preschool Dimension of Mastery Questionnaire 18(Study 3). Ratings and direct assessment using the FOCUS app can support corroborated findings of mastery motivation. In 2020, we also adapted the Childhood Executive Functioning Inventory (CHEXI) (study 4). Having adapted the tools, we assessed the direct and indirect effects of executive functions and mastery motivation on the academic performance of children in grade 1(study 5). The results of study 3 provided further empirical evidence of the role of mastery motivation and executive functions on school readiness. Finally, combining these tools with the FOCUS app, we implemented study 6 to assess the suitability of using FOCUS as a school readiness kit in Kenya.

6.1 Study1: Scoping Literature Review of Game-Based Assessment of School Readiness Domains

6.1.1 Objectives

This scoping review aimed to establish whether the computer games, apps or game-like features used as assessment tools (from here on referred to as Game-Based Assessment (GBA)) are employed in the assessment of the following child school readiness domains: (1) Cognition and general knowledge; (2) approaches to learning; (3) physical well-being and motor development; (4) social and emotional development; and; (5) language development (Kagan et al., 1995; Sabol & Pianta, 2017). Previous reviews have focused on these apps' training capabilities but not on assessing school readiness. The paucity of information about the efficacy of game-based tablet

assessments makes it unclear whether such assessments should be recommended to support teachers and parents in making critical decisions about children's education.

6.1.2 Method

A scoping review is a type of research synthesis that "aims to map the literature on a particular topic or research area and provide an opportunity to identify key concepts; gaps in the research; and types and sources of evidence to inform practice, policymaking, and research" (Daudt et al., 2013, p.8). We adopted the following steps in conducting the scoping review: (1) identifying the research questions; (2) identifying relevant studies; (3) selecting studies; (4) charting the data; and (5) collating, summarising, and reporting the results (Arksey & O'Malley, 2005, p.22).

Step1: Identifying the Research Questions

This scoping review aimed to identify how GBA has been implemented to assess school readiness domains. The following research questions guided this scoping review:

RQ1: What are the main characteristics of studies in GBA of school readiness domains? Which countries are involved? Which knowledge, skills or abilities related to school readiness are assessed? Are these assessments done in schools or outside schools?

RQ2: What measurement type and instruments does each assessment adopt? What are the psychometric properties of these tools?

RQ3: What type of performance data analyses are employed by these studies? Are these analyses on the process or product data?

RQ4: How is the outcome of the GBA used to enhance the development of school readiness domains?

These research questions will help provide guidelines to construct a computer-based assessment of school readiness in Kenya.

Step 2: Identifying Relevant Studies

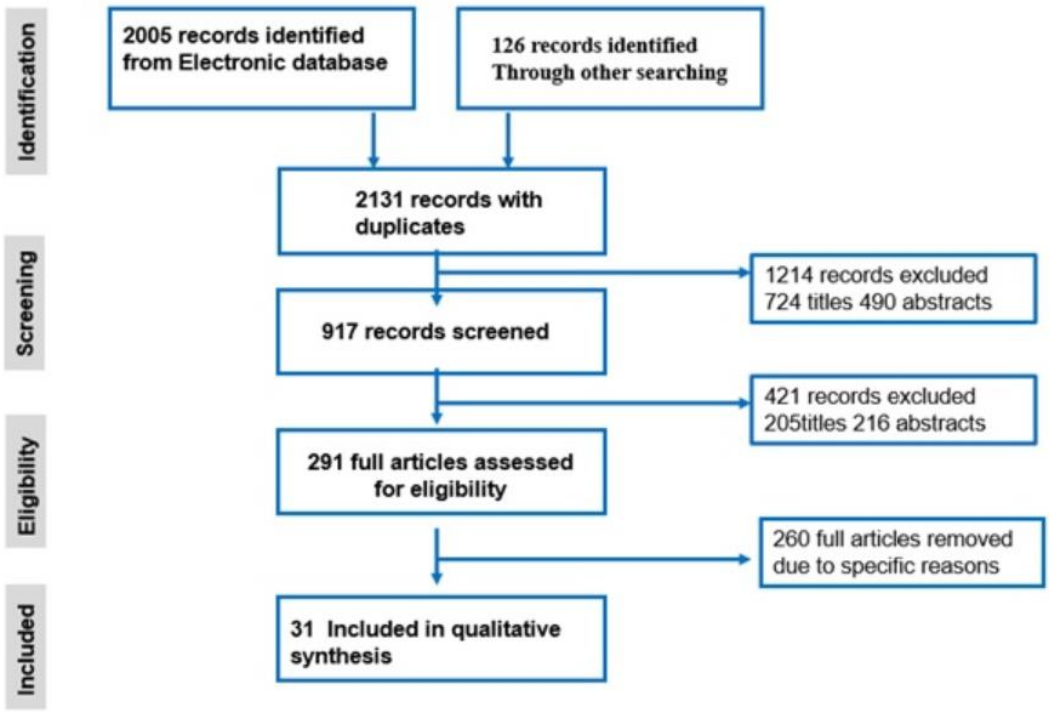
For inclusion and exclusion, we adopted a similar procedure by Caballero-Hernández et al. (2017, p. 46). We adopted the following exclusion criteria: (i) Out of

scope: articles earlier than 2010 were excluded since serious games began effectively after 2010 (Ifenthaler et al., 2012); (ii) Unsupported language: languages other than English; (iii) Off matter: textbooks on general assessment and test theories but not a game-based assessment; (iv) Duplicated: article already included from another database; (v) Off topic: assessments of other subjects or ages other than children. We followed a systematic search in the following databases, PsycINFO, ERIC, SCOPUS, ACM Digital library, Science Direct, Web of Science, IEEE Xplore, and SpringerLink. We designed a Boolean search as follows; "Game-based assessment" OR "game learning analytics" OR "children apps" AND "validation" OR "evaluation" AND "school readiness domains: "cognitive" OR "approaches to learning" OR "language" OR physical OR "socio-emotional" OR "numeracy" OR "science" OR "knowledge" OR "skills" OR "abilities" OR "education" AND "children" OR "childhood". Figure 8 shows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram (Moher et al., 2009) that we followed during this review.

Springer Link had the highest number of studies and conference proceedings in GBA, followed by Web of Science, as shown in Table 4. Most of the studies identified focused more on middle school and above.

Figure 8

Flow Diagram of the Study Selection Process



Selection of the studies

All the selected databases were collected together in Zotero Electronic Referencing Management software. Within this database, we selectively implemented the inclusion and exclusion criteria. We coded the articles into the five school readiness domains; (1) cognition and general knowledge, (2) approach to learning; (3) physical well-being and motor development, (4) social and emotional development; and (5) language development; (Kagan et al., 1995; Sabol & Pianta, 2017). This coding gave a broad range of articles to search and opportunities for further investigation. Table 5 presents the results of the studies that met the inclusion and exclusion criteria.

Table 5

Selected Empirical Studies and Journal Avenues

	Study	Country study conducted	Journal source
[1]	(Hsu et al., 2011)	Taiwan	Journal of Science Education and Technology
[2]	(Bottino et al., 2014)	Italy	International Journal of Game-Based learning
[3]	(Craig et al., 2015)	USA and Japan	games for health journal
[4]	(Godwin et al., 2015)	USA	international journal of gaming and computer-mediated simulations
[5]	(Geurts et al., 2015)	Belgium	Advances in game-based learning
[6]	(Enrique Agudo et al., 2016)	Spain	journal of universal computer science
[7]	(Moyer-Packenham et al., 2016)	USA	mathematics research journal
[8]	(Ninaus et al., 2016)	Finland	games and learning alliance
[9]	(Gresalfi et al., 2016)	Sweden	AERA online
[10]	(Axelsson et al., 2016)	USA	Journal of educational psychology
[11]	(Aragon-Mendizabal et al., 2017)	Mexico	Anales de Psicologia
[12]	(Józsa et al., 2017a,b)	Hungary	Electronic Journal of Research in Educational Psychology
[13]	(Ow & Tan, 2017)	Malaysia	IEEE Conference on e-Learning, e-Management and e-Services (IC3e),
[14]	(Chiu & Hsieh, 2017)	Taiwan	EURASIA Journal of Mathematics, Science & Technology Education
[15]	(Puolakanaho & Latvala, 2017)	Finland	Human Technology
[16]	(Loachamín-Valencia et al., 2018)	Spain	Artificial intelligence and Bioinformatics
[17]	(Behnamnia et al., 2018)	Malaysia	Social-Informatics and Telecommunications Engineering
[18]	(DeRosier & Thomas, 2018)	USA	Journal of applied developmental psychology

[19]	(Lee et al., 2018)	USA	Frontiers in Paediatrics
[20]	(Mironcika et al., 2018)	Netherlands	Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction
[21]	(Obradovic et al., 2018)	USA	journal of applied developmental psychology
[22]	(Miller, 2018)	Canada	International journal of stem education
[23]	(Omella Mainieri et al., 2018)	Brazil	Latin American Conference on Learning Technologies (LACLO)
[24]	(Cohrssen & Niklas, 2019)	Australia	Assessment for effective intervention
[25]	(Ford et al., 2019)	Lebanon-Niger	research in comparative and international education
[26]	(Neumann & Neumann, 2019)	Australia	international journal of research & method in education
[27]	(Bhavnani et al., 2019)	India	Global Health Action
[28]	(Shih et al., 2019)	Taiwan	Educational Psychology
[29]	(Rauschenberger et al., 2019)	Germany	ACM International Conference proceeding
[30]	(Willowbully et al.2019)	Kenya	Developmental Science
[31]	(Xin et al., 2018)	China	Acta Psychologica sinica

Data Analysis Strategies

The authors coded all the articles according to the school readiness domains. After coding, we pooled studies that assessed similar school readiness domains together. Where there was a lack of consensus among the authors, we sought a third opinion. Then we checked the article's suitability for assessing the domain claimed guided by the Evidence Centred Design (ECD: Mislevy et al., 2006) framework. The ECD framework seeks to identify evidence in the educational assessment, such as "what, where, and how are we measuring, and how much do we need to measure" (Kim et al., 2016, p. 3). The authors discussed their suitability based on the evidence for studies that did not categorically state the models as stipulated by the ECD framework.

6.1.3 Results

General Characteristics of the Empirical Studies on GBA

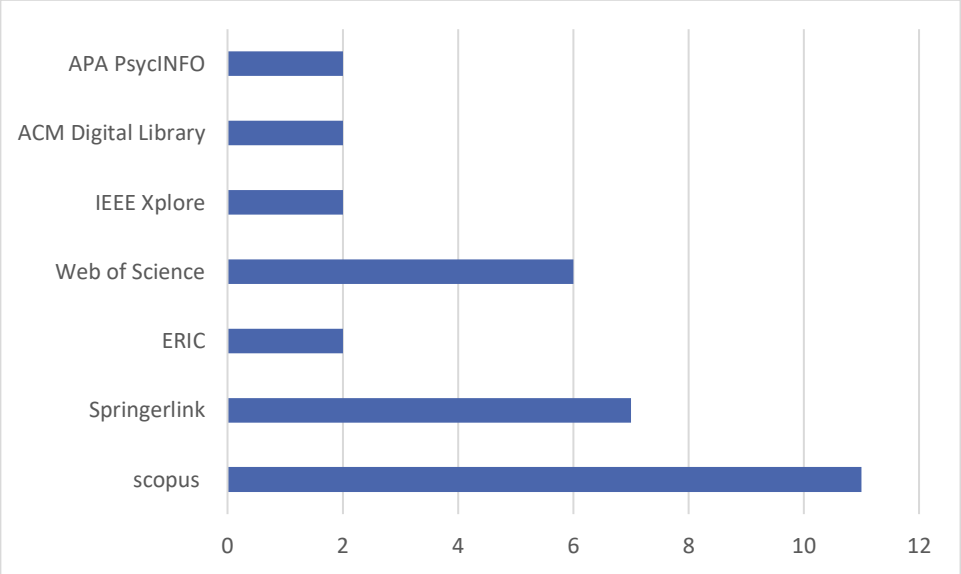
(a) Distribution of the empirical studies by database

Following the inclusion and exclusion criteria, we included 31 articles for the review. Scopus had the highest number of articles (n =11). PsycINFO, ACM, IEEE Xplore and ERIC had the least—two studies each (Figure 4). However, some databases

shared some articles to avoid duplication, and the articles were registered once. The studies came from different parts of the world. Europe had the highest representation with *n* = 10 studies, followed by North America *n* = 8, Asia *n* = 8, Australia and South America *n* = 2 and Africa *n* =1, as shown in Table 4. The most represented country was the USA (n = 7), followed by Taiwan (n = 3), then Australia, Finland, Malaysia and Spain had *n* = 2 studies each.

Figure 9

Distribution of Studies in the Selected Databases

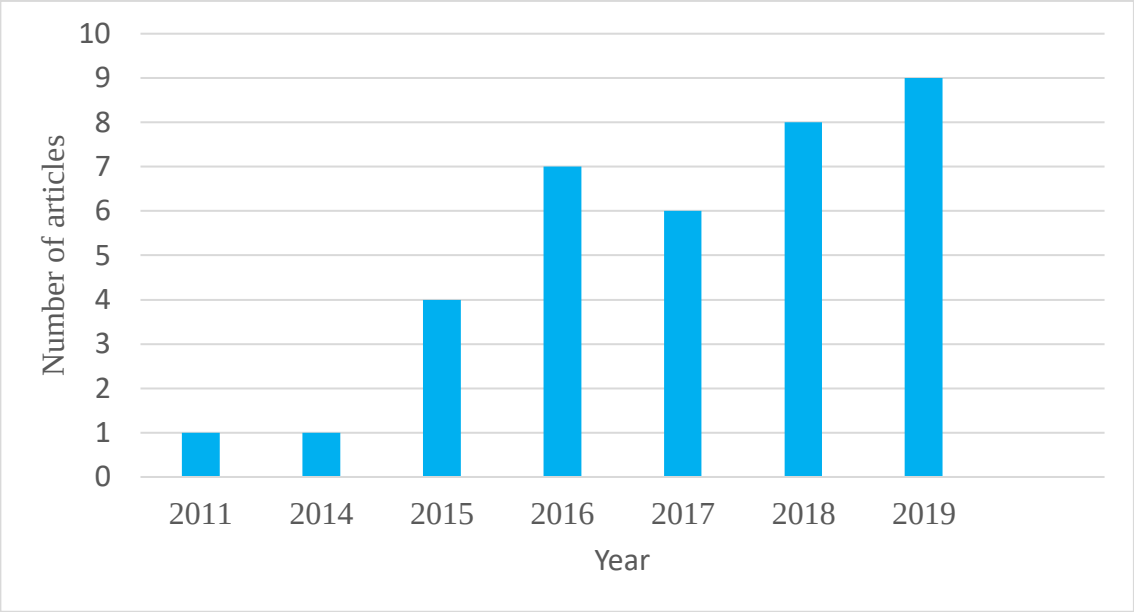


(b) Distribution of the empirical studies by year

From 2011to 2019, the number of empirical studies on GBA of school readiness increased ninefold, as shown in Figure 10. In 2012 and 2013, no studies directly targeted school readiness domains for children 3-8 years old. Nevertheless, there is an upward trend of studies addressing school readiness assessment.

Figure 10

The trend of Studies in GBA of School Readiness Domains from 2011-2019.



We also investigated the settings where these studies were conducted. Only one study by Bhavnani et al. (2019) was done outside school settings in children's homes. All the other studies were conducted in school settings but offline and were not formalised in the school curriculum as preferred assessment methods. GBA has an opportunity to provide a different form of assessment, even in homes and online, especially when schools are not accessible in the event of a pandemic.

(c) School Readiness Domains assessed using GBA

We identified each school readiness domain considered in each study. Most empirical studies assessed cognitive domains (n = 25). Cognitive competency refers to the ability of the child to process information. It is divided into two: subject-specific and general cognitive skills. The subject-specific cognitive domain is mostly supported by teaching and learning through a particular curriculum. The subject-specific cognitive skills featured in the empirical studies were arithmetic (n = 8), reading or letter recognition (n = 5), English (n =1) and science (n =1). On the other hand, general cognitive skills are not necessarily taught in a classroom situation, but they are essential in problem-solving (Suleiman et al., 2016). The studies in this review assessed, memory (n = 1), critical thinking (n = 1), attention (n =1) and reasoning (n = 2). Five studies assessed executive functions, which involve working memory and cognitive switching

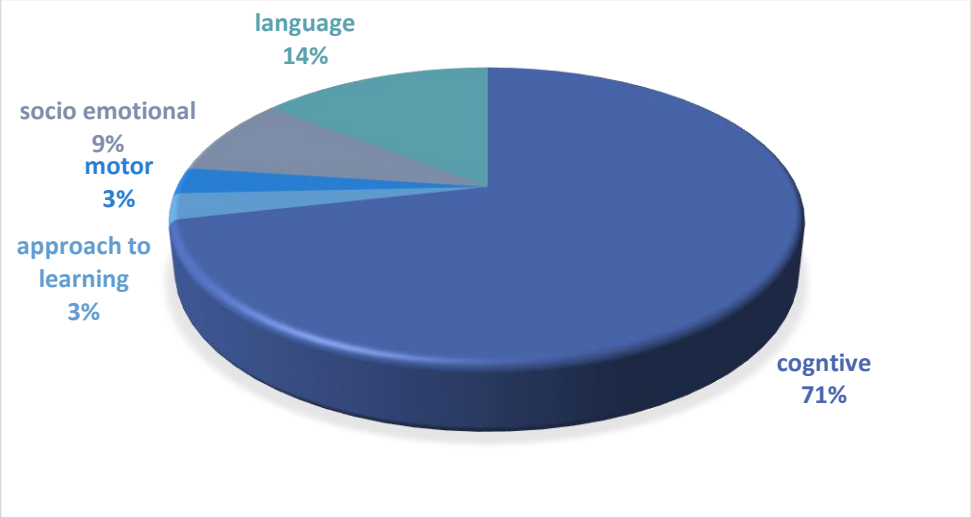
and could be construed as general cognitive skills, but they also involve inhibitory control and are sometimes viewed as approaches to learning.

Socio-emotional development was only measured in *n* = 3 studies, with two studies evaluating the social aspect and one on emotions, as shown in Table 6 and Figure 11. Socio-emotional development involves children's understanding and regulation of emotions and behaviour and skills for interacting with others at school, all of which are important for participating effectively in classroom activities. Physical well-being and motor development featured in only one study addressed fine motor skills. This domain is significant in early childhood since it facilitates learners' writing and manipulative play (e.g., constructing puzzles) during teaching and learning.

As mentioned earlier, executive functions can be viewed either as general cognitive skills or approaches to learning. If viewed as approaches to learning, there were six studies on this school readiness domain. However, only one GBA study was conceptualised to study approaches to learning (Józsa et al., 2017). Approaches to learning is an umbrella term for traits that help children learn. They include focus, enthusiasm, flexibility, persistence, and motivation. Recent studies have demonstrated the significance of approaches to learning on academic performance, perseverance when faced with challenging tasks, problem-solving creativity, and children's socio-emotional development (Hunter et al., 2018).

Figure 6

School Readiness domains assessed by GBA



Task Performance in GBA studies

Based on the Evidence Centred Design framework (Mislevy, 2006), for each study, we coded whether it had a specific task for the school readiness domains and the nature of the evidence that was provided for that readiness domain. A task is defined as "a unit of activity that the student attempted, which produces a work product" (Kim et al., 2016, p. 4). In GBA, it can be a multiple-choice question, game level or, in some instances, a very complex interaction. How we measure that task constitutes the evidence model (de Klerk et al., 2015). Most GBA offered three types of assessments of these tasks: external, embedded and game scoring during the game activity. The work products sometimes were captured as observed data, either process or a product of the task performance. Most of the external assessments only assessed the final product, but the embedded type produced both process and product data (see Table 5). All the studies N = 31 had explicit tasks provided, although the tasks varied depending on the competency's nature. The students were provided with Multiple Choice Questions or interviews after the GBA for external assessment. Three studies compared the effectiveness of GBA and traditional tests, Hsu et al. (2011), Loachamín-Valencia et al. (2018) and Neumann & Neumann (2019). These studies concluded that GBA is better than pen and paper formats. Other studies with intervention strategies had a similar conclusion, as shown in Table 5.

Analysis of Performance Data Based on the Tasks

Tasks performed by learners can either be analysed as a process or a final product. These different types of measures require different methods of analysis. Two branches of research have emerged in educational assessment on this front. The first is educational data mining techniques that explore the relationship between competency and performance-based tasks (Rupp et al., 2010). The second emerging branch is computational psychometrics which employs complex models such as Bayesian Networks that use performance data to make probabilistic decisions about learners' skills(e.g.Almond et al., 2015; Arieli-Attali et al., 2019). However, some studies in the current review did not explicitly declare the method of performance data analysis they adopted. Therefore, we investigated n = 12 studies that adopted the embedded assessment type. In this type of assessment, the log file registers the process and the various performance product data. Of these 12 studies, only four studies, Craig et al. (2015), Lee et al. (2018), Puolakanaho & Latvala (2017) and Willowbully et al. (2019),

indicated the psychometric or statistical model they employed to score or process the performance data, as shown in Table 5. The other studies reported how the output was integrated into their data analysis strategies instead (e.g., Ford et al., (2019) indicated they adopted SAS).

Nevertheless, n = 8 studies provided how the scoring was done, and *n* =10 provided a model of the relationship between the competency to be assessed and the observed work product, as shown in Table 5. Ten studies adopted external assessment; *n* = 8 had external and embedded assessment types, while *n* = 14 studies assumed only embedded type of assessment. The most common external assessment tools were the multiple-choice questions and the interview. Most questionnaires targeted teachers and parents, while the one for children only had simple images to indicate whether they enjoyed the game or not. The log file analysis was the most preferred assessment method for the embedded type. Unfortunately, only three studies indicated the program they will deploy to analyse the log files: Microsoft excel, a high-order DINA model for the problem-solving and scoring algorithm.

Psychometric Evidence Provided by the Empirical Studies

We also investigated the Psychometric properties described by the studies of GBA. Of the articles selected, *n* =16 studies did not indicate any psychometric evidence in their studies. Studies that addressed general cognitive skills, mainly executive functions, had an elaborate test for psychometric properties (Ford et al., 2019; Obradovic et al., 2018; Willoughby et al., 2019). These studies determined correlations with the existing tools for assessing executive functions to establish concurrent validity. Some studies, e.g., Obradovic et al. (2018), further reported the ecological and predictive validity of the tool (Table 5).

Table 6

GBA Types and Psychometric Properties of the Studies

	GBA type	Tasks	Observed variable	Analyses	psychometric evidence
[1]	External	MCQ test and interview on shadow	Process	N	N
[2]	external and embedded	MCQ test on transversal skills	Process	N	N
[3]	Embedded	embedded test of six types of social skills	Process/product	Scoring algorithm	Validated
[4]	In-game and external	smile questionnaire	Process	N	Concurrent validity
[5]	External	phonological test	Process	N	N
[6]	External	questionnaire and classroom observation	Process	N	N
[7]	External	interview test(pre-post), quantitized videos	Process	N	N
[8]	In-game and external	Embedded	Process and product	N	N
[9]	Embedded	questionnaire	Product	N	N
[10]	External	embedded test	Product and process	Scoring formula	N
[11]	Embedded	Early numeracy test	product	N	N
[12]	Embedded	the embedded measure of Mastery Motivation and Executive Functions	Process	N	Reliability and validity
[13]	Embedded	embedded test on six critical thinking skills	Process	N	N
[14]	External	questionnaire and embedded test	product	N	N
[15]	external and ingame	pencil and paper tasks and in-game scoring computer-based tasks	Process and product	Statistical model	Correlation with other tasks
[16]	external and embedded	embedded and compared with traditional	Process	r-software	Concurrent validity
[17]	external and embedded	Pen and paper; in-game scoring	Product and process	N	validity
[18]	Embedded	embedded algorithm scores student menu selections and in-game social behaviours	Process	Scoring algorithm	validity
[19]	Embedded	Weschler tests and embedded cognitive TAG tests	Process	Bayesian Nets	validity
[20]	Embedded	embedded fine motor tasks	Process	N	N
[21]	Embedded	embedded Executive Functions tasks	Process	Response Time analysis	Reliability and validity
[22]	External	score test on numerical cast on a screen	product	N	N
[23]	external	Questionnaire	Process	N	validity
[24]	external and ingame	pre-post numerical tests	product	N	N

[25]	Embedded	embedded Executive Functions tasks analysis	Process	SAS	N
[26]	In-game scoring and external	completed receptive tests delivered via a tablet and pencil and paper	Process	Inbuilt scoring	Reliability and validity
[27]	External	questionnaire and interviews	product	N	Reliability and validity
[28]	Embedded	problem-solving tasks measured by HO-DINA model	Process and product	HO-DINA model	N
[29]	Embedded	embedded telemetry/dyslexia	Process	N	N
[30]	Embedded	embedded Executive Functions tasks analysis	Process	Confirmatory factor analysis	Reliability and validity
[31]	Embedded	Logfile analysis and pre-post test	Process	Machine learning algorithm	N

Note. MCQ – Multiple Choice Questions; N – None or it was not reported

School Readiness Intervention Strategies Adopted by GBA Studies

Studies with an intervention component adopted experimental or quasi-experimental designs to test the intervention's efficacy in school settings. Studies that adopted survey methods had a larger sample size compared to the ones that adopted experimental techniques. The smallest sample size was 5 participants, while the largest, which assessed executive functions as one of the general cognitive skills, had 1480 participants. However, of all interventions targeting 3-8-year-old children, only n = 8 studies aimed their intervention toward school readiness (Table 6). The n = 10 studies that addressed subject-specific cognitive skills such as science, arithmetic, and English aimed to solve the challenge of poor performance and attitude towards those subjects. However, supporting individual learning of subject areas contributes positively to school readiness. Two studies, Rauschenberger et al. (2019) and Geurts et al. (2015), aimed to identify the risk of developing dyslexia in children as they prepare to join the school and possible early intervention strategies to adopt.

Table 6

Study Designs and Intervention Strategies of the Studies

	Intervention	Domain assessed	study design	N
[1]	Acquisition of scientific concepts regarding light and shadow	science	experimental	50
[2]	Triggering and sustaining students' reasoning and logical abilities	reasoning	quasi-experimental	60
[3]	N	social skills	correlational	497
[4]	N	sustained attention	correlational	27
[5]	detect a high risk for developing dyslexia	phonological	correlational	25
[6]	English acquisition	English-Executive FunctionsL	Descriptive	35
[7]	N	arithmetic	mixed methods	100
[8]	validate conceptual knowledge of fractions	arithmetic	quasi(pre-post)	54
[9]	early learning of equivalence and ordering infractions	arithmetic	correlational	65
[10]	N	executive functions	correlational	161
[11]	reduce the risk of developing problems learning mathematics	arithmetic	quasi-experimental	156
[12]	N	Mastery Motivation &Executive Functions	correlational	247
[13]	N	Six critical thinking skills	correlational	20
[14]	improve maths achievement and attitudes	fractions	quasi(pre-post)	100
[15]	Predict early reading skills-slow and normal	phonological	quasi(pre-post)	57
[16]	auditory stimuli for assessing short-term spatial memory	spatial reasoning	correlational	35
[17]	collaboration through social apps	social skills	quasi(pre-post)	32
[18]	N	socio-emotional skills	Correlational	270
[19]	N	Cognitive	Correlational	40
[20]	games can be introduced in smart toy to improve fine motor skills to improve handwriting	fine motor skills	Correlational	30
[21]	N	executive functions	correlational	269
[22]	increase engagement of learners in the teaching of maths	arithmetic	mixed methods	13
[23]	practising the arithmetic operations of addition, subtraction and multiplication	arithmetic	mixed methods	20
[24]	Supporting children's engagement with mathematical	arithmetic	quasi(pre-post)	79

	ideas and numeracy development.			
[25]	N	Inhibitory control and working memory.	correlational	850
[26]	measure early literacy skills	the letter, word, and numeral skills	quasi(pre-post)	99
[27]	N	Six cognitive skills	Correlational	100
[28]	performance of computational estimation in addition and subtraction	computational skills	Correlational	729
[29]	Early detection of dyslexia	reading and writing	correlational	5
[30]	N	executive functions	correlational	1480
[31]	N	arithmetic	Quasi(pre-post)	360

Note. EF – Executive Function; EFL – English as a Foreign Language; N – not reported

6.1.4 Discussion

Despite the importance of school readiness, there has been a serious debate regarding being ready for school (UNICEF, 2012). This theoretical understanding has implications for how school readiness will be assessed. Some studies recommended the school's readiness, community, family and the child, while others focused on the child's readiness to learn or perform at the school level (Stein et al. 2019). We focused on child-centred school readiness for this scoping review and examined the domains stipulated by the National Educational Goals Panel (Kagan et al., 1995; Sabol and Pianta, 2017).

Many instruments have been developed to assess school readiness, both paper and pencil, and are technology-based (Csapó et al., 2014). However, in this online era, the use of GBA to assess children's domains has received surprisingly little attention and yet over 80% of children's apps target pre-schoolers. Since children love games and most apps and video games are produced for children (Behnamnia et al., 2018), we sought to determine if studies on GBA have considered assessing these school readiness domains. We based our review on evidence centred design (Mislevy et al., 2006).

Over 70% of the reviewed studies assessed cognition and general knowledge. This is due to overemphasis on intellectual factors that affect academic performance rather than non-intellectual factors such as approaches to learning (Li et al., 2019). The socio-emotional domain's other frequently assessed competency but not widely featured in GBA, with only two studies. Although socioemotional skills are malleable, their assessment has usually been done using the teacher's behavioural ratings, requiring training to interpret and suffer from psychometric challenges (de Rossier and Thomas,

2018). A performance-based assessment like a GBA could directly identify the socio-emotional needs of the children. Another cognitive competence that did not receive the attention it deserves was the language domain, with only 5 (14%) of the studies measuring this competency. There was only one study on fine motor development to prepare children to write readiness for school. However, games that influence physical activity, popularly known as active video games or "exergames", have impacted intellectual skills, executive functions, and health outcomes (Merino-Campos & Del Castillo Fernández, 2016).

Each study provided a series of tasks to assess the school readiness domains for the children. Ten studies (33%) provided tasks in a pre-post experimental design. This approach does not provide enough evidence to analyse what happens in the game itself. This design has been criticised for not analysing the complex process/performance data that can be used to inform 21st-century educational skills (Suleiman et al., 2016). To solve this "black box" issue, we need to measure GBA in real time with automated scoring. One of the frequently employed analyses in such situations is Bayesian Networks. Bayesian networks allow one to make a probabilistic statement of latent variables under investigation based on the observed variables (Almond, 2015). This further supports learning by providing information about the processes underlying performance on the assessment, enabling other learner attributes to be measured and supported (de Klerk et al., 2015; Suleiman et al., 2016). This type of assessment is interwoven into the fabric of the gameplay, such that children imagine they are enjoying playing a game, but in the background, complex skills and domains are assessed, which is referred to as stealth assessment (Kim et al., 2016). The video game industry seems to have taken advantage of learning analytics or educational data mining by providing non-disruptive tracking methods that visualise the process of playing the game (Carvalho et al., 2015). If GBA were to adopt similar procedures, teachers could be more comfortable identifying children's challenges in processing information, problem-solving approach, creativity, critical thinking, and other process variables rather than scores alone (Serrano-Laguna et al., 2017). Although 14(42%) studies had embedded tasks into the game, only 3(10%) indicated their stealth assessment's nature.

The studies also presented different intervention strategies to help children on their journey to school. Two studies offered unique solutions to detect and remedy dyslexia-a learning disorder prevalent among 5-15% of children, affecting reading and writing (American Psychological Association, 2013). These studies employed the

Human Centred Design approach to develop systems and experiments. Only four subjects were featured in the subject-specific cognitive domain: science, arithmetic, reading/pre-reading, and English, and almost all GBAs just assessed one of these subjects. However, other subjects are more commonly offered for children in preschool, such as music and creative arts; moreover, accurate arithmetic and English grammar are rarely included in preschool curricula. Neumann and Neumann (2019) 's study was unique since it offered numeracy and literacy skills assessments. The other study that assessed more than one school readiness attribute was by Józsa et al., 2017. This study assessed two approaches to learning (executive functions and mastery motivation) and pre-academic skills, specifically letter and number recognition. All the other studies assessed only one competency or skills related to one competency alone. Despite all studies adopting most of the Evidence Centred Design framework components, only one study by DeRosier and Thomas (2018) recognised this framework's utility and actively implemented it.

6.1.5 Conclusions

The number of studies focusing on GBA of school readiness domains is increasing, although there is too much focus on cognitive domains at the expense of non-cognitive domains that are very useful in developing 21st Century skills such as Approaches to Learning. The review only identified one app used to assess Approaches to Learning domains, mastery motivation and pre-academic skills, the FOCUS APP. The Evidence Centred Design framework can guide game designers to improve these assessments' psychometric properties during their development. Most GBA that adopted embedded assessments did not indicate how the performance data was analysed for process and product data. However, those that employed external assessment in a pre-post design had implemented positive intervention strategies to improve school readiness.

6.1.6 Suggestions for Further Research

Additionally, the majority of these studies were carried out in school settings. Therefore, GBA has a unique opportunity to be applied both in formal classes and at home. In situations where children cannot attend school due to pandemics, school enhancement programmes can continue at home. We strongly recommend using GBA with other established instruments to give the teacher and parents a broader spectrum to make correct decisions concerning the child. We agreed to develop further the app assessing

mastery motivation and executive functions for the Kenyan context from this study. We agreed to build an easy-to-use app to share, assess more than one school domain, and adopt an evidence-centred design to fill this gap.

6.2 Study 2a: Validation of FOCUS Application in Kiswahili Version

6.2.1 Objective

The objectives of this study are threefold: (i) Re-design, develop and adapt the FOCUS app following Design-based research to suit the Kenyan context. This approach is relevant in this study due to the bigger objective of involving preschool teachers, encouraging them to adopt FOCUS during school-readiness tests and intervening with children with low academic achievement. (ii) Determine the psychometric properties of the newly adapted app; (iii) Determine stability (test-retest) of FOCUS in a longitudinal study of children in two waves, from preschool to grade 1. Additionally, we wanted to examine how the item functions in the Kenyan context.

6.2.2 Method

Participants

After getting the Institutional ethics review approval and authority to conduct the study in Kenya, we stratified preschools into private and public. We recruited preschool children in the last term in pre-primary II in the rural areas of a large coastal county of Kenya using stratified random sampling. Only 9% of the children came from private schools and the rest from public schools. In the rural areas of Kenya, most children attend public schools; however, in major cities like Nairobi and Mombasa, the two major cities, more children attend private schools than public schools (Willoughby et al., 2019). We randomly recruited 103 children in the third term of pre-primary 2; 8 failed the first training task, and 6 had less than 10% of the recorded data and were removed from the sample. Finally, 89 children whose ages ranged from 60 to 132 months with a mean age of 77 months (SD=1.09). Out of the 89, 47(53%) were boys, and 42 (47%) were girls. According to the Kenya National Early Childhood Policy (2015), the expected age is five years. Unfortunately, after the promulgation of the New Constitution, in 2010, Kenya declared free primary education. This has attracted all the children who had dropped out or had other challenges in going to school. Therefore, only 17 children (19.1%) were within the expected age range of 5 years in this sample.

Most children in the study area also attend preschool when they are much older than the expected school-going age, especially in public schools. Since Swahili is predominantly spoken, 81(91%) students preferred the Swahili version of FOCUS, while only 10(9%) preferred the English version. The children predominantly speak Swahili both at home and school. At the time of the study, the children were typical normal and of Kenyan origin. Their parents were mostly subsistence farmers, with the majority having only completed primary school education.

Procedure

Before using the tablet measures, teachers rated the pupils using the preschool DMQ-18. The DMQ-18 includes an adult-report measure of cognitive persistence similar to the FOCUS app's directly assessed mastery motivation measures. The FOCUS session began with the researcher filling in the login screen with a user identification and password. After filling in the child's age and gender, the researcher gave each child an anonymous ID number. After setting these details, the child was given a tablet with a set of headphones. The narrator, the little puppy, provides instructions to children on what task they are supposed to undertake since children are not fully competent in reading. Before each task, there are a set of training slides to familiarize the child with the task. After a series of warm-ups, the children were allowed to proceed with the experiment. Any child who felt uncomfortable proceeding with the experiment was allowed to leave, and their data was deleted from the system.

Measures

Four measures were adopted for this study. FOCUS App for assessment of pre-academic skills and mastery motivation, Preschool DMQ 18 for cognitive persistence and task motivation assessment. These tools are described in the methodology section.

Data Analysis Plan

The first two tasks on the FOCUS app, number recognition and alphabet recognition, were used to measure pre-academic school readiness. The number of items answered correctly on each task was transformed into a percentage correct score and compared using paired sample *t*-test to see whether Kenyan pre-schoolers showed higher pre-reading or pre-math readiness performance. In addition, the percentage of participants who responded correctly to a particular age item was obtained (Peña, 2007). The time spent on the moderately challenging letter search

and number search tasks (in seconds) was captured, and the average across the two tasks constituted the mastery motivation score. The moderately challenging tasks were developed based on data from the Hungarian sample. The average time spent persisting on each moderately challenging task was later standardized (M=1, SD=0) to get the individualized moderately challenging computer score (IMCC). Then, these scores were correlated with one another and with the results of the DMQ, as well as being used to predict performance in first grade. In addition, stability and grade level-related change in number recognition, alphabet recognition, and mastery motivation were assessed. Using G*Power 3.1.9.4, the sample size of 84 was big enough to yield a medium effect size at a power of 80% and an alpha level of 0.05 for correlation and regression tests (Cohen, 1992).

6.2.3 Results

Reliability

Pre-academic Skills Tasks

Tasks 1 and 2 of FOCUS assessed number and alphabet recognition. Both number and alphabet recognition had 15 items each. The number and alphabet recognition reliabilities were high: Cronbach alphas were 0.84 and 0.94, respectively. Moreover, the paired sample *t*-test indicated that the performance of number recognition (M = 47, SD = 20.21) and letter recognition (M= 69, SD = 20.21) tasks were significantly different at $\alpha = .05$, $t\ (86) = -7.45$, $p < .001$, with the alphabet being recognized to a greater extent than numbers. Item 14 and 15 in number recognition were the most difficult for 60-70 months children, with a paltry 6% and 4%, respectively.

(ii) Mastery Motivation and Competence on Letter and Number Search Tasks

We calculated three computer-generated scores for the letter and number search tasks. These were; Computer-generated time spent attempting the letter or number search task, which we called Time Spent Persisting (TSP), Percentage of Matching Symbols Found (PMS), and Computer Search Competence score (CSC). TSP is considered the central measure of mastery motivation, and the other two scores are measures of competence on the tasks, which can be used to gauge how difficult each task is for the child. Comparable scores have been used with the Hungarian and American English versions of FOCUS, indicating whether these tasks are appropriate for the Swahili Version of FOCUS. TSP is important as a measure of mastery motivation because it shows the time spent persisting not only while succeeding, i.e. correctly matching the numbers or letters, but also while attempting to match numbers or letters and making errors (DiCerbo, 2014; Shute, 2011; Ventura et al., 2013). Table 8 shows the time spent attempting both number and alphabet search across four tasks that are assumed to range in difficulty for the children, based on work with children in other countries of the same age: (1)

easy, (2) moderately challenging 1 (3) moderately challenging 2 and (4) hard. Generally, the time taken increased across the tasks from easy to hard in the older age groups for both tasks, but it increased only for letter search for younger children, perhaps indicating that number search was too challenging for younger children at the medium and hard levels.

Table 8

Average Time Spent Persisting during Number and Letter Search Tasks in Seconds

Age in months	Number Search					Letter Search			
	Difficulty levels					Difficulty levels			
	N	Easy	MC1	MC2	Hard	Easy	M1	M2	Hard
60 to 70	17	48(21)	47(21)	68(46)	65(23)	36(28)	51(26)	52(31)	51(35)
71 to 84	46	62(26)	53(23)	71(88)	108(132)	35(23)	80(103)	60(51)	82(59)
85 or more	26	61(29)	88(61)	123(118)	119(109)	67(45)	62(45)	62(44)	86(59)

MC1 = Moderately challenging 1, MC2 = Moderately challenging 2,; SDs are in parentheses

Computer Search Competence Score (CSC)

CSC is the average percentage of the letters or numbers that were matched correctly, taking into account those that were not matched correctly, i.e. errors, for all difficulty levels. For example, if a student correctly matched 60% of the cards and failed to match 40% (i.e. errors) accurately, the CSC will be computed as (60+100-40)/2. Table 9 shows that, generally, the CSC declined from the easy to hard tasks in both number and letter search tasks.

Table 9

Computer Search Scores for Number and Letter Search tasks

	Number Search					Letters Search			
	N	E	MC1	MC2	H	E	M1	M2	H
5 to 6	17	74(24)	66(17)	62(15)	55(13)	70(23)	62(17)	60(14)	53(5)
6 to 7	46	67(22)	66(20)	65(20)	64(18)	76(23)	65(20)	64(16)	55(8)
7 or more	26	68(21)	66(18)	64(16)	61(15)	83(23)	67(19)	62(16)	56(13)

Note. E = Easy, MC1 = moderately challenging 1, MC2 = Moderately challenging 2, H = Hard; SDs are in parentheses.

Internal consistency reliability (Cronbach's alpha) was computed for the FOCUS measures Time Spent Persisting (TSP), Percentage of Matching Symbols Found (PMS) and Computer Search Competence Score (CSC), as well as for cognitive persistence as rated by teachers using the preschool motivation questionnaire, DMQ 18, see Table 10.

Table 10

Internal Consistency of Letter and Number Search Tasks

Reliability	Computer-based Scores			Preschool Motivation Questionnaire (DMQ 18)		
	CSC	PNMC	TSP	TCP	TMP	TNR
Cronbach Alpha	.854	.748	.824	.708	.915	.852
NL Correlation	.492	.246	.794	-	-	-

Note. (N=89) CSC = Competence on the search tasks; PNMC = Percentage of Non-Matching Cards found; TSP = Time Spent Persistence on the four tasks assumed to be moderately challenging; TCP = Teachers' Rating of Cognitive Persistence on the DMQ 18; TMP = Teachers' ratings of Mastery Pleasure on the DMQ 18, TNR = Teachers' ratings of negative reaction to failure on the DMQ 18, NL=number search-letter search.

The reliability values shown in Table 3 were between 0.7, which is good, to 0.9 excellent (Gliner et al., 2017). Average correlations between the number and letter search tasks were also calculated for the three computer-based scores. According to Cohen's (1988) criteria, these correlations ranged from low to very large, and all three were significant.

(a) Validity

Prior research has provided preliminary support for the validity of the English and Hungarian language versions of FOCUS when used with U.S. and Hungarian samples (Józsa et al., 2017). Therefore, as a first step toward validating the Kenyan English and Kiswahili versions with a Kenyan sample, we first correlated mastery motivation scores from FOCUS with those from the teacher-report DMQ-18, administered separately (concurrent validity). Second, correlated mastery motivation scores from one type of FOCUS task with that measure during another FOCUS task (concurrent validity). Third, it analyzed how well the game-based assessment predicted a future outcome it was expected to predict (predictive validity; Homer et al., 2018).

Concurrent Validity

To examine the concurrent validity of the computer-based assessment tasks, the time on the child remains focused on two moderately challenging tasks on number and letter search was standardized (M = 1, SD = 0) to come up with an individualized moderately challenging computer score (IMCC). This score is a measure of cognitive persistence. IMCC correlated positively with the cognitive persistence subscale of the Preschool Dimensions of Mastery Questionnaire (DMQ) 18, $r = 0.33$, $p < 0.001$ providing evidence for concurrent validity (Table 11).

Table 11

Correlation of the Different FOCUS Measures with each other and with the DMQ 18

	1	2	3	4	5	6
DMQ Persistence						
IMCC Persistence	0.357**					
PMS	0.208*	0.509**				
PNM	0.137*	0.110	0.483**			
CSC	0.303*	0.498**	0.793**	- 0.151		
Pre-academic skills	0.079*	-0.016	-0.147	- 0.339**	0.070	

DMQ =Dimension of mastery questionnaire; IMCC persistence= the average time spent moderately challenging tasks, PMS=Percentage of Matching Symbols Found (PMS), CSC = Computer Search Competence Score (CSC), PNM=Percentage of Non Matching Cards found

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

As a second method of measuring concurrent validity, mastery motivation on the search tasks was correlated with mastery motivation on the Picture Memory tasks. To assess mastery motivation from Picture Memory tasks, each child received one task that was expected to be easy, one expected to be medium, and one expected to be difficult for that child at that age. The time taken to complete the picture memory task was correlated with Time Spent Persisting (TSP) in the number and letter search task. IMCC correlated positively with persistence on the Picture Memory Tasks 18, $r = 0.535$, $p < 0.002$ providing further evidence for concurrent validity.

2.6.2 Predictive Validity

A simple linear regression was also calculated to predict pre-academic skills in grade one based on the average time spent on moderately challenging tasks (IMCC persistence) as an independent variable and the percentage score of the sum of letter and number recognition tasks as the dependent variable. A significant regression equation was found $F(1, 84) = 10.879$, $p < .001$ with $R^2 = .115$ again providing evidence for predictive validity.

6.3 Study 2b: Stability of the Newly Developed FOCUS Application

In this phase, we tracked 89 children who participated in study 1 the following year when they joined the elementary school. The method of data collection was similar to study 2a.

6.3.1 Method

Participants

Out of the expected 89 children (47 boys and 42 girls) in preschool, we could locate 51 children (30 boys and 21 girls) in the next year immediately after the end of year vacation in different

schools. The remaining 38 were either retained in preschool, dropped out, or their parents transferred them outside the County. The children had a mean age of 6.53 years (SD=1.19) minimum age was five years, and the maximum was ten years.

Procedure

The session began with the researcher filling in the login screen with user details. After filling in the child's age and gender, the researcher gave each child a unique and anonymous ID number. Next, the tablet language was set according to the teacher's preferred language of daily classroom instruction. After these details were set, the child could proceed with the experiments.

Results

The results showed that there was no longitudinal growth between waves 1 and 2 in mastery motivation, as measured by IMCC, but, unfortunately, there was a significant difference in letter recognition, with fewer letters being recognized at Grade 1 compared with the preschool level (Table 12). In addition, although correlations between performance at wave 1 and wave 2 were all significant, they were low to moderate in size, suggesting that although there was some stability of individual differences in mastery motivation and pre-academic skills (particularly number recognition), there was also a change. Unfortunately, this data was not provided due to extensive missing data of the executive function section caused by random source code challenges. Instead, we revised the source code again and planned another iterative cycle.

Table 12

Stability of FOCUS App Assessment of Children's Pre-academic Skills, Mastery Motivation and Executive Functions

	Constructs	Pre-school May 2019 Wave 1(N=89)		Primary School January 2020 Wave 2 (N=51)		*t*	*r*
		M	SD	M	*SD*		
1	Pre-academic skills						
	Number recognition in %	47	20.21	45.36	26.53	0.356	0.424**
	Letter recognition in %	69	20.21	54.12	32.68	2.571*	0.233*
2	Mastery Motivation						
	TSP in Sec	77.47	57.46	64.82	51.33	0 .712	0.301*

Note. 1st wave = 5- 6years, 2nd wave = 6-7 years. Paired *t*-test used to examine stability.
TSP – Time Spent Persisting; IMCC - Individualized Moderately Challenging Computer score
* $p < .05$, ** $p < .01$, *** $p < .001$.

6.3.1 Revision of Executive Functions Data Conversion process

After evaluating and analysing the data, we reflected on the quality of data obtained from Executive Function tasks. We were concerned about the level of missing data, specifically on executive function tasks. Since observation tools were used together with the FOCUS app, there was evidence that there was not missing by chance, but the system had failed to convert them successfully. Due to the challenges experienced with the previous version of the data converter, especially the executive functions tasks. We revised the source code to develop a better and more dynamic converter built on the Python-Django package. The server is critical to allow researchers to collect and collate data automatically from the field. Towards this end, we developed the following functional requirements of the FOCUS app. First, the user should be able to log in from the web to view student results. Second, the back end should allow the upload of raw android SQLite databases for storage. Third, the web displays aggregated and categorised student results from the uploaded databases. This careful design is shown in the architectural design in Figure 12. For the examiner to upload data, the back end of the FOCUS App will expose the following API route; http://<ip>/upload/ - Used for uploading raw android SQLite databases and http://<ip>/auth/login – Used for user authentication. Additionally, to facilitate viewing of the data on the server, the user will need to have the login credentials provided by the server administrator as follows; http://<ip>/- Homepage with user login form and http://<ip>/admin – Provide an interface to the Administration portal for viewing database records.

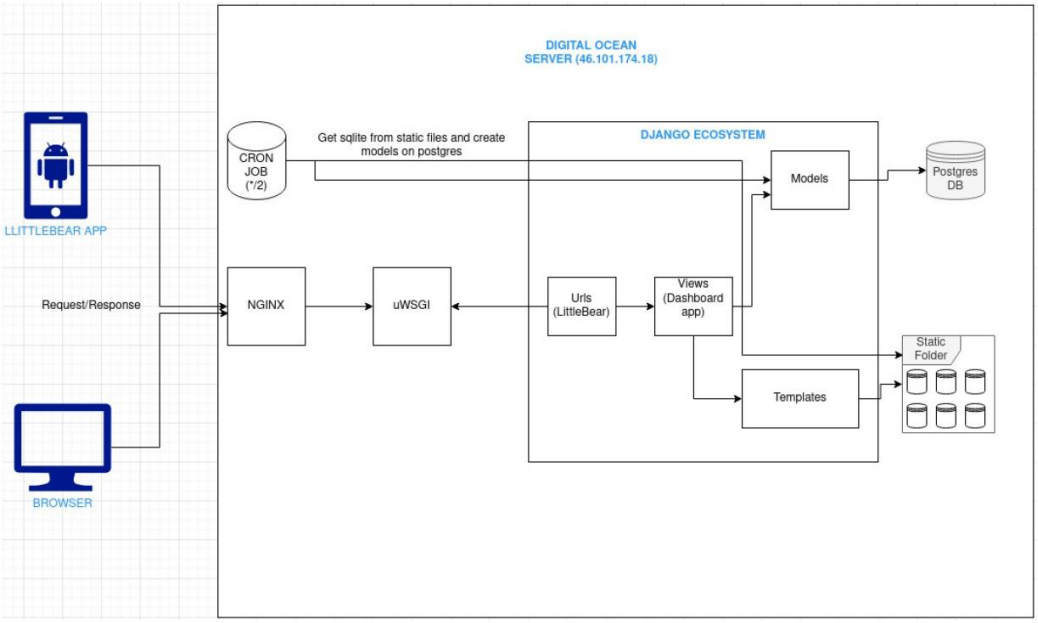
Data Conversion Procedure

After data collection in the field, it is imperative to convert the data to .csv or excel from the App (Figure 12) to facilitate further data analysis either in SPSS, MPlus or other data analysis programs. To convert the data to excel, simply follow the following procedure. First, create a folder in a safe and easy to access location on your computer .i.e Folder Named "FOCUS_CONVERTED" on your desktop. Second, obtain the python script "get_table.py" file and save it to the folder above. Third, use a browser [preferably Chrome, Edge or Firefox], login to the LittleBear web application, and press "Ctrl + s" to save the web page. The browser will display a pop-up requesting to save the webpage; make sure you navigate to the above FOCUS_CONVERTED folder and save it there. Four, open folder FOCUS_CONVERTED and on the blank address bar, press the space bar, type in “cmd” to open the terminal (cmd prompt) and run the script ``` get_table.py```, which will create**.csv and .xlsx** file when done. i.e.**11_02_2022_21_01M_21**_LittleBear.csv and **11_02_2022_21_01M_21_**

LittleBear.xlsx, where the name in bold is the date and time when the file was created. To view the data, open the files in excel or .csv.

Figure 12

Revised FOCUS app Architectural Design



6.3.2 Design Principles Identified During FOCUS app Construction

One of the crucial stages of EDR is to identify principles that can be used in future to improve the design and application. Several strategies were identified during the design and construction process, i.e. design principles that can be recommended during further revisions.

Table 13

Design Principles and Strategies Adopted During Design and Construction

Principle	Strategy
Establish communication channels between all collaborators	▪ Schedule activities in a standard calendar ▪ Prompt feedback to all member contributions ▪ The researcher takes the central role as a participant and a resource person ▪ An open social networking site for all members of the team, e.g., WhatsApp group
Strategic competencies of team members	▪ Computer programmers' speciality should be in tandem with the design at hand ▪ Native speakers(English and Swahili) for translation

	▪ Experts in curriculum designs
Choice of digital tools	▪ Incorporate open source tools where possible ▪ Avoid tools with short turnover ▪ Continuous maintenance of source code to keep up with the changes in technology
Cultural sensitivity	▪ To avoid biases during translation and adaptation, select a competent committee that represents the source and the new language
Product Source Code	▪ Whatever the source code agreed upon, the programmer should include comments after every block of codes to facilitate continuity in the future during revision and iterations

During the first and second pilot evaluations, we identified the ratio of missing data in session 2, and the executive function tasks were more significant than expected. In addition, we recorded several tasks and pursued them in the output data set, and we discovered that some sessions were randomly missing in the output. We, therefore, pursued two strategies to fix the challenge.

(1) Manual Validation of Executive Function Tasks

To ensure the code registered all the tasks taken using the app, we took the tasks and manually recorded the responses or answers on a physical piece of paper. We noted the time taken in each task the recorded answers, and sometimes we intentionally picked wrong answers to confirm if they would be registered. After recording all the responses on paper, we followed each task in the system database. The app records all the tasks successfully taken on a database folder which can be viewed through the settings option, then choose browse database. We manually confirmed all the tasks we did from this database and confirmed them on the database folder. We confirmed successfully that all the tasks were loaded into the database. This assured the team that the app records the tasks, and the challenge does not emanate from the app but may be the conversion process.

(ii) Development of a new Converter

After confirmation that the app registers all the tasks successfully, we pursued the development of a new converter using a different computer programming language-Python web development framework-Django. The advantage of this framework is that it is versatile, scalable and secure. We have developed a new output in the HTML format using this open-source framework. However, the HTML format is not friendly for further data analysis; therefore, it has to be converted using other freely available online tools to .csv or Microsoft Excel files. We, therefore, have two converters; online and offline based. It is, therefore, easier to confirm the dataset from either version.

6.3.3 Discussion

A study of 70 longitudinal studies by La Paro and Pianta, 2000 revealed a correlation between pre-academic skills at preschool and academic achievement in grades 1 or 2 of about .12 to .87. In addition, reading achievement is related to letter knowledge, word recognition and vocabulary (Muter et al., 2004). On the other hand, a child's mathematics concepts such as counting, number recognition and visual discrimination have been established to have predictive power on academic achievement (Duncan et al., 2007). We, therefore, administered each child with two tasks to assess pre-academic skills, number and letter recognition. The computer tablet-based tasks had a database that generated five computer-based scores; Time spent persisting(TSP), Percentage of matching cards found (PMC), and Percentage of non-matching cards touched (PNM). Percentage of completely successful trials, Computer search competence score (CST). When undertaking these tasks, all computer-based scores, together with examiner ratings and DMQ ratings, were used to calculate the reliability of the computer-based assessment. The FOCUS app had good reliability of over .7 in all subscales. Validity was determined by correlating persistence on the individualised moderately challenging computer-based tasks with teachers' ratings of DMQ cognitive persistence and examiners' persistence ratings. The correlation was significant, r = .33 and .25, respectively (Józsa et al., 2017). Since every learner can input their data onto the tablet, the results are expected to be individualised.

Assessment of mastery motivation, as opposed to executive functions, has been chiefly done using teacher and parent or self-reports. Such reports suffer from implicit bias, and in their place, direct assessment or a combination with reports is preferred (Li, 2019). Since examiners proficient in interpreting direct assessments are lacking in

LMIC, a computerised assessment is preferred since it will remove the examiner's task of collecting and collating data. For this reason, researchers are advised to develop tools that are easy for examiners and participants (Diamond, 2016). FOCUS has the potential to save time on administration of tasks, data collection and storage. Unlike other school readiness tools that focus on assessing one construct, FOCUS assesses three constructs, thus providing more information regarding school readiness.

Additionally, the stored data for each student can be tracked longitudinally. This makes interventions to improve academic achievement genuinely possible. We recorded FOCUS tasks in English in a Kenyan accent and Swahili, which worked very well for the children. This allowed them to choose the language of their choice freely. However, in a similar study by Willoughby et al. 2019 in Kenya, results indicated no significant difference in task performance, whether presented in Swahili or English. Therefore, the feasibility of using this application for measuring school mastery motivation was good. The percentage completion rate was exceptionally high, over 80%, in pre-academic and mastery motivation tasks, similar to Józsa et al. (2017). Reliability values for FOCUS tasks were above 0.7, indicating that it was reliable in the Kenyan context. Criterion validity was also confirmed by correlating positively with the preschool DMQ 18 cognitive persistence subscale with FOCUS app tasks and predicting future academic performance. We also followed ITC guidelines (2018) to maintain content validity and reduce cultural biases. Additionally, the face validity of computer-based tasks is much higher than the self-report measures of persistence since it measures behaviour in real-time (Ventura et al., 2013).

The results of study 2 showed that there was no change in number recognition from preschool to grade 1 and that letter recognition declined. This could be due to the long vacation before the school year, indicating that children in this study rarely review their schoolwork at home. This also supports the call that children face many difficulties during preschool to school transition in Kenya, and there is a need to develop strategies to enhance transition (Amukune, 2021). FOCUS also showed one-year stability for mastery motivation tasks, although the correlations were small to moderate in size. Importantly, mastery motivation at preschool significantly predicted letter and number recognition at grade 1, suggesting that it is a valuable part of school readiness assessments. Although there was no significant difference in mastery motivation between the two waves, there was no attempt to improve mastery motivation integration in the Kenyan curriculum. Other studies have shown that students with low mastery motivation

are at risk of poor academic achievement and might require some intervention (MacPhee et al., 2018). However, mastery motivation is malleable, and children with low SES benefit most from interventions (McDermott et al., 2014). Several studies (e.g., Mercader et al. 2017; Mokrova et al. 2013) have shown a correlation between mastery motivation and academic skills.

Limitation of the Study

Despite excellent data sets for pre-academic skills and mastery motivation, executive functions results had missing data due to either child touching the narrator, little puppy or random system failure. We have implemented a series of revisions to update the code structure and correct the data file converter to correct this challenge. However, on thorough scrutiny, the programmers referred to the error as random, and therefore the following revision was dedicated to identifying and fixing this problem.

6.3.4 Conclusion

Initial feasibility tests of the FOCUS app have shown it is valid and reliable in the Kenyan context to assess pre-academic skills and mastery motivation. The availability of such an app in Kiswahili will fill a large void in Kenya and Africa in general since over 150 million people speak Swahili. Assessment of mastery motivation and executive functions will also help the teachers and parents predict Approaches to Learning and plan possible intervention strategies. However, assessment of academic achievement alone is not enough for school success. Therefore, we strongly recommend that preschool assessments also measure non-cognitive skills such as mastery motivation and plan intervention strategies as a long-term measure to address school and life success. The FOCUS app can complement other school readiness tools like KSRT in Kenya.

6.4 Study 3: Swahili Version of the Dimensions of Mastery Questionnaire: Adaptation and Psychometric Properties

6.4.1 Objectives

The objective of this study was fourfold. Firstly, to translate the Preschool DMQ 18 from English to Swahili. A Swahili version is critical since most parents and preschool teachers are more fluent in Swahili than in English. Additionally, Swahili is spoken by over 200 million people in Africa and other parts of the world. Swahili is the only native African language that has received international recognition from UNESCO, and it is celebrated every 7th of July annually. Other African bodies have also endorsed Kiswahili as their official language, such as the African Union (UNESCO, 2021). This version will open more studies in Kenya and Africa in general. The second is to determine the psychometric properties of the Swahili version in the Kenyan context. The third is to compare the ratings of parents and teachers who are the primary users of the DMQ 18. Fourthly, compare children's mastery motivation above the minimum age requirement for preschool and older ones. Lastly, we compared the Kenyan rating of the preschool DMQ 18 ratings with the preliminary norms to judge whether the ratings were above the normative scale.

6.4.2 Method

Participants

A total of 397 preschool children were sampled from one of the counties in Kenya. Due to the diversity of preschools in this region, schools were placed into four strata: rural but public school, rural but privately owned, urban but publicly owned and rural but privately owned. From each stratum, three schools were chosen randomly. From each school, children were selected using simple random sampling. We recruited pre-primary II children, a second-year class for children attending preschool in Kenya. Children in pre-primary II have spent over a year with the teacher and have built up a two-way relationship; hence they are easier to evaluate. Children below three years do not attend preschool classes (Republic of Kenya, 2017). Of the 397 preschoolers chosen randomly, 210 (52.9%) were male and 187 (47.1%) female. Their ages ranged from 5 to 12 years (M=6.93, SD=1.40) as follows: 5-6 years, 203 (51.13%), 7-8 years, 136 (34.26%), 9-10 years, 46 (11.59%) and 11-12 years, 12 (3.02%). It is common to find children older than six years attending preschool classes in Kenya. This is mainly due to the Government declaration that elementary education is free and compulsory

(Republic of Kenya, 2010), and therefore all children who had dropped out or had other challenges are strongly encouraged to go back to school.

Instruments

Subscales of the Preschool DMQ 18 as the Research Instrument

The Preschool DMQ 18 has seven sub-scales (Huang et al., 2020). The first four scales are related to the instrumental (persistence) aspects of mastery motivation. They are (1) Object/Cognitive persistence scale (five items), e.g., "Works for a long time trying to do something challenging";(2) Gross motor persistence scale (five items), e.g.,"Tries to do well in physical activities even when they are challenging (or difficult)"; (3) Social persistence with adult scale (five items), e.g., "Tries to figure out what adults like"; (4) Social persistence with children/peers (six items), e.g., "Tries hard to make friends with other kids". The next two scales assess expressive/affective aspects of mastery motivation. (5) Mastery pleasure measures the positive affect after finishing or while working on a task with five items, e.g., *"Gets excited when he or she figures out something"*; (6) The negative reactions scale has eight items focusing on sadness/shame, e.g., *"Seems sad when he or she does not accomplish a goal"* and frustration/anger, e.g.,"*Gets upset when he or she can not complete a challenging task*". Lastly, the general competence scale has five items, e.g., *"Solves problems quickly*". The five items in the subscale are averaged as follows to compute the child's cognitive persistence: (1+14+17+23+29)/5. Averages are calculated for gross motor persistence (3+12+26+36+38)/5; social persistence with adults (8+15+22+33+37)/5; social persistence with children (6+7+25+28+32+35)/6; mastery pleasure (2+11+18+21+30)/5; negative reactions for both frustration and anger (9+13+16+19+5+24+34+39)/8; and finally, general competence (4+10+20+27+31)/5.

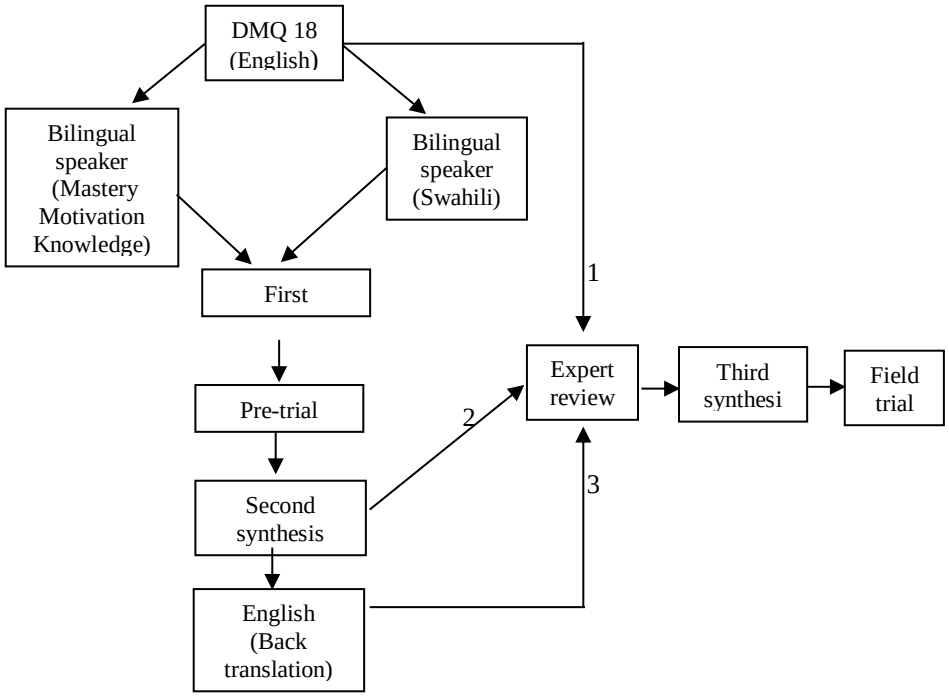
Procedure

Translation of the Preschool DMQ 18 from English into Swahili

After requesting official permission from the original developer of the DMQ 18, we followed the procedure suggested by Fajranthi et al. (2020) and Sousa and Rojjanasrirat (2011) to translate and validate the Swahili version of the Preschool DMQ 18. A committee approach was adopted composed of two bilingual English and Swahili speakers working with a research institution as linguists, current researchers, experts in mastery motivation, and preschool teachers (International Testing Commission (ITC), 2018; Fajranthi et al., 2020). The two bilingual translators did the forward translation from English into Swahili (Figure 13). One was versed in the concept of mastery motivation, while the other was knowledgeable in Swahili and acquainted with the cultural nuances of Swahili speakers in Kenya. The two forward translated documents were presented to a committee for the first synthesis. Specific words that were ambiguous in the Swahili translation were 'mastery motivation, 'puzzles', 'motor activities', and 'physical activities'. After deliberations among the committee members, the first version of the Swahili translated tool was developed. This tool was subjected to scrutiny by five parents and 11 teachers, all of whom were graduates specialising in Early Childhood Education and with over five years of teaching experience in Kenyan preschools. These teachers were qualified to teach 3- to 8-year-olds. All the parents involved had at least an undergraduate degree and worked at a research institution. This small sample was checked for colloquial phrases, slang, jargon and emotionally evocative terms that should be removed or replaced in the translated questionnaire (Sperber, 2004). The objective of this exercise was to reduce different interpretations to the minimum (Hwang et al., 2017).

Figure 13

Process of Translating the Original English Preschool DMQ 18 into Swahili



Note: All of the versions were submitted to the experts for expert review

1 - Original Preschool DMQ 18 in English

2 - DMQ 18 translated into Swahili

3 - Back translated from Swahili into English

The Swahili version of the tool was back-translated into English by an independent bilingual translator who had not read the original English version. A back-translation procedure was adopted to compare it with the source questionnaire's original expression (Sperber, 2004). This translator had a PhD in English and published several books for children and teenagers in English. The back-translated version, the original English version and the Kiswahili version were combined into one document and forwarded to the experts who developed the Preschool DMQ 18 (Fajranthi et al. 2020). The aim was to ensure that the content validity was maintained and that the Swahili instrument would assess mastery motivation.

One of the committee's experts, an English native speaker, compared all the items and gave further feedback. Out of 39 items, 30 (79%) items were comparable and similar to the original questionnaire. However, some words that were not correctly translated included 'persist', 'shows excitement', 'smile broadly', and 'interested'. Using

the comments by the expert, the committee deliberated on the wording and adopted alternative words. This version was accepted, and a small-scale field trial was conducted involving 16 parents (Shaoli et al., 2019). After completing the questionnaire, the 16 parents (preschool teachers) were brought together for a focus group discussion. All the items presented were discussed one after the other, and clarifications were agreed upon. This final version, consisting of the original English version, the back-translated and the refined Swahili version, was presented to an independent expert in the Swahili language for final confirmation. The committee then approved this final Swahili version of the Preschool DMQ 18 for data collection.

Data Collection

Before data collection, the researchers sought ethical approval from the University of Szeged, the Institutional Research Board and the National Council for Science Technology and Innovation in Kenya. Both parents and teachers were requested to sign a consent form after full disclosure of the study and its procedure. Two research assistants, one with an M.A. degree and the other with a first degree, helped collect data. Teachers rated 397 children from 12 preschools using the Swahili version. ITC (2018) recommended a sample size above 300 during the adaptation of questionnaires. However, Floyd and Widaman (1995) proposed a ratio of subjects-to-variable ratio of 5:1. In this study, 39x5 gave 195. To assess the questionnaire's test-retest reliability, a sample of 50 children was rated for the second time by their teachers (Shaoli et al., 2019). To get a teacher-parent comparison, a subsample of 50 children from the primary sample was randomly selected, and their parents were asked to rate them for the second time using the Swahili version of the Preschool DMQ 18. Test-retest reliability was derived after examining the intra-class correlation coefficient (ICC). Using a sample size requirement table for the intra-class correlation with the power of 80% at an alpha level of .05, a sample size of 50 was sufficient (Bujang & Baharum, 2017). A third subsample from the primary sample, consisting of 20 children, came from teachers' ratings using the English version of Preschool DMQ 18 to determine the parallel form reliability of the Swahili version.

Data Analysis Plan

Data analysis involved two main steps. Firstly, to obtain reliability, means, standard deviations and correlations using IBM SPSS 23. First, the internal consistency reliability (Crbα; Chronbach alpha), composite reliability (CR: Raykov, 1997), and test-retest reliabilities were computed to judge the instrument's reliability. Values above .70 indicated good reliability (Hair, 2014). Secondly, to establish validity, confirmatory factor analysis (CFA) was computed using Mplus 7 (Muthén & Muthén, 2012) to investigate the operationalised measurement model of the Preschool Dimensions of Motivation Questionnaire (Morgan et al., 2020). Finally, to determine the estimation procedure, Mardia's coefficients of multivariate kurtosis and its critical ratios < 5.0 were used to judge the data's normality (Mardia & Kanazawa, 1983).

The following model fit indices, and their cut-offs were used to assess the model fit: Root Mean Square Error of Approximation (RMSEA) < 0.08, Tucker-Lewis Index (TLI) ≥ 0.90, and CFI ≥ 0.90) (Schreiber et al., 2006; Schumacker & Lomax, 2010). Traditionally, the chi-square statistic has been employed to assess model fit; but it is strongly dependent on the sample size (Kline, 2015). An AX^2/df range between 2 and 5 gives an acceptable fit of the observed sample data and the hypothetical model (Schumacker & Lomax, 2010). Most studies prefer TLI, CFI and RMSEA as measures of goodness of fit (Schreiber et al., 2006). Convergent validity was determined by examining the average variance extracted (AVE), higher than 0.50, with a high CR. of above .70 (Hair et al., 2010). Concurrent validity was determined by correlating the data collected using the English version of the Preschool DMQ 18 and the Swahili version.

6.4.3 Results

Internal consistency and reliability

Internal consistency was computed for all seven subscales: gross motor persistence, cognitive persistence, mastery pleasure, social persistence with adults and children, negative reactions and general competency. Reliability values for both internal consistency and test re-test were above .70, which was satisfactory. The negative reactions (α = .91) had the highest reliability values compared to the other language versions (Table 14).

Table 14

Cronbach's Alpha of the Kiswahili DMQ-18 and other Language Versions

Study	Country	Language	N	COP	GMP	SPA	SPC	MP	NR	GC
Present study	Kenya	Kiswahili	397	.83	.85	.89	.89	.91	.91	.89
Shaoli (2019)	Bangladesh	Bangla	206	.89	.94	.89	.88	.85	.83	.86
Salavati et al. (2018)	Persia	Persian	230	.76	.74	.61	.62	.68	.65	.80
Özbey (2017)	Turkey	Turkish	207	.86	.84	.88	.87	.88	.84	.91
Józsa & Morgan (2015)	Hungary	Hungarian	211	.93	.96	.91	.90	.90	.79	.94

Note: COP=Cognitive persistence; GMP=Gross motor persistence; SPA=Social persistence with adults; SPA=Social persistence with children; MP= Mastery pleasure; NR=Negative reactions; GC=General competence

Test-retest reliability

After two weeks, the subsample of 50 children from the primary sample was randomly selected and rated by their teachers for a second time to compute the test-retest reliability. Table 15 lists the test-retest intra-class correlation coefficient (ICC) values that ranged from .80 to .94.

Parallel Forms Reliability

Two weeks after data collection, another sample of 20 children was randomly selected from the primary sample. The teachers again rated this sample using the English version of the Preschool DMQ 18. Their rating was compared with the Swahili version's Preschool DMQ 18 to determine the reliability of parallel forms. The reliability of the six subscales ranged from .57 to .87, but gross motor persistence was the lowest at .57 (Table 15). The total persistence was also satisfactory with $r = .88$, $p < 0.01$. Nevertheless, the total reliability was acceptable with $r\,(20) = .76$, $p < 0.01$.

Table 15

Test-retest ICC and Parallel Forms Reliability of Preschool Teachers' Ratings after two Weeks of Administering the Swahili version of Preschool DMQ 18

Subscales	Items	Cronbach's alpha	Test-retest ICC	Parallel form reliability
Cognitive/Object Persistence	5	.83	.80	.80
Gross Motor Persistence	5	.85	.89	.57
Social Persistence with Adults	5	.89	.82	.87
Social Persistence with Children	6	.89	.86	.82
Mastery Pleasure	5	.91	.94	.76
Negative Reactions	8	.91	.89	.73
General Competence	5	.91	.86	.76
Total Reliability of all scales	39	.95	.87	.76

Note. $p < 0.01$

Factorial Validity

We first analysed the seven-factor model, as suggested by Schreiber et al. (2006). Since the data had no missing values and were not normally distributed and ordered with a high ceiling effect, we adopted the WSMV estimation method (Brown, 2015). The CFA results indicated an unacceptable model fit of our data, with a broad competencies scale displaying unfitting estimates. When we removed this dimension, the model fitness improved significantly ($\chi^2 = 1132.72$; df = 413; $p < 0.001$; CFI = 0.973; TLI = 0.970; RMSEA = 0.069) (Schreiber et al., 2006; Schumacker & Lomax, 2010). The standardised factor loading, composite reliability and average variance extracted of the Preschool DMQ 18 in Swahili, as rated by teachers, are shown in Table 16

Table 16

Standardised Factor Loadings, Average Variance Extracted (AVE), and Construct Reliability (CR) of Subscales of the DMQ 18 Swahili Version rated by Teachers

	Items	Factor loading	AVE	CR
No.	DMQ Scales/items			
	Cognitive/object persistence		0.600	0.89
1	Repeats a new skill until he or she can do it	0.869		
14	Tries to complete tasks, even if it takes a long time to finish	0.871		
17	Tries to complete games like puzzles even if it requires a lot of effort	0.672		
23	Works for a long time trying to do something challenging	0.722		
29	Will work for a long time trying to assemble something	0.715		
	Gross motor persistence		0.608	0.92
3	Tries to do well at athletic games	0.784		
12	Tries to do well in physical activities even when they are challenging	0.873		
26	Repeats sports skills until he or she can do them better	0.765		
36	Tries hard to be better at sports	0.762		
38	Tries hard to improve his or her ball-game skills	0.706		

Table 16 (continued). *Standardised factor loadings, average variance extracted (AVE), and construct reliability (CR) of subscales of the DMQ 18 Swahili version rated by teachers*

	Items	Factor loading	AVE	CR
No.	DMQ Scales/items			
	Social persistence with adults		0.694	0.93
8	Often discusses things with adults	0.860		
15	Tries hard to interest adults in his or her activities	0.838		
22	Tries hard to get adults to understand him or her	0.819		
33	Tries to find out what adults like and do not like	0.863		
37	Tries hard to understand the feelings of adults	0.784		
	Social persistence with children			
6	Tries hard to make other children feel better if they seem sad	0.835	0.700	.94
7	Tries to say and do things that keep other children interested	0.833		
25	Tries hard to understand other children	0.903		
28	Tries hard to make friends with other kids	0.809		
32	Tries to get involved when other kids are doing something	0.840		
35	Tries to keep things going for a long time when playing with other kids	0.795		
	Mastery pleasure		0.796	0.95
2	Is pleased with self when he or she finishes something challenging	0.874		
11	Gets excited when he or she is successful	0.907		
18	Gets excited when he or she figures something out	0.913		
21	Is pleased when he or she solves a problem after working hard at it	0.906		
30	Smiles when he or she succeeds at something he or she tried hard to do	0.860		

Table 16 (continued). *Standardised factor loadings, average variance extracted (AVE), and construct reliability (CR) of subscales of the DMQ 18 Swahili version rated by teachers*

	Items	Factor loading	AVE	CR
No.	DMQ Scales/items			
	Negative reactions		0.862	.93
5	Seems sad or ashamed when he or she does not accomplish a goal	0.949		
9	Gets frustrated when not able to complete a challenging task	0.931		
13	Gets frustrated when he or she does not do well at something	0.946		
16	Protests after failing at something that he or she tried hard to do	0.953		
19	Tries to get adults to see his or her point of view	0.930		
24	Won't look people in the eye when he or she tries but cannot do something	0.871		
34	Looks away when he or she tries but cannot do something	0.925		
39	Withdraws after trying but not succeeding	0.920		

Convergent validity

The standardised factor loadings for the six-factor model were all above 0.70, except for one item that scored 0.6 in the cognitive persistence subscale, "*Tries to complete toys like puzzles even if it involves hard work*". Standardised loadings of 0.5 and above are acceptable but preferable if they are above 0.7 (Hair et al., 2014). All the values in the measurement model were above 0.5 in the six-factor model, confirming convergent validity. The AVE was computed for each subscale based on the standardised factor loadings. An AVE value of above 0.5 suggests good convergence, while a value lower than 0.5 suggests more errors in the item than the variance explained by the latent factor structure (Hair et al., 2010). Table 16 indicates that the values ranged from 0.6 to 0.86, above 0.5, confirming convergent validity. In addition, the high composite reliability of above 0.7 (Table 16) confirms convergent validity (Hair et al., 2014).

Divergent Validity

Using the Fornell-Larcker criterion, the square root of AVE on the diagonal (Table 17) was higher than the correlations of the scales with each other, thus confirming good divergent (discriminant) validity (Fornell & Larcker, 1981). Furthermore, the results showed that the latent factor of DMQ 18 explains 60% to 86% of the variance in the items. Since all the items had a variance above 30%, this also suggests good reliability (Bollen, 1989).

Table 17

Inter-Correlation for the six-factor model and Average Variance Extracted (AVE) of the Preschool DMQ 18 rated by Preschool Teachers

	MP	COP	GMP	SPC	SPA	NR	AVE
MP	**.892**						0.796
COP	.769	**.775**					0.600
GMP	.609	.594	**.780**				0.608
SPC	.724	.619	.731	**.837**			0.700
SPA	.492	.486	.625	.787	**.892**		0.694
NR	.610	.714	.544	.471	.372	**.928**	0.861

Note: COP=Cognitive persistence; GMP=Gross motor persistence; SPA=Social persistence with adults; SPA=Social persistence with children; MP= Mastery pleasure; NR=Negative reactions; Diagonal figures in bold are the square root of AVE; all correlations are significant ($p<0.0001$).

Comparison of the Rating of DMQ 18 by Preschool Teachers and Parents

Teachers' and parents' ratings were compared using a paired sample t-test. Preschool teachers rated their students highly on the cognitive persistence scale (M = 3.92, SD = 0.50) and gross motor persistence (M = 3.77, SD = 0.62) was lowest on the persistence scale. Mastery pleasure was rated the highest (M = 4.22, SD = 0.64) and sadness/shame the lowest (Table 17). The results of the parent-teacher comparison using a paired sample t-test showed that parents rated their children higher on gross motor persistence, $t(49) = -3.75$, $p < 0.001$ and social persistence with children $t(49) = -2.86$ $p = 0.006$. The differences in cognitive/object and social persistence with adults were insignificant. The teachers rated the children higher on the expressive scale, but these differences were also not significant. In the persistence scales, significant correlations were found between parents' and teachers' ratings of social persistence with adults ($r = 0.30$, $p < 0.05$) and with children ($r = 0.39$, $p < 0.001$). In the expressive

scales, significant correlations were found between teachers' and parents' ratings for both mastery pleasure ($r = 0.29$, $p < 0.05$) and negative reactions to failure ($r = 0.45$, $p < 0.001$).

The correlation of parents' and teachers' ratings provided corroborative evidence of the validity of response processes (AERA, 2014) since the parents observed the child's mastery-oriented behaviour at home while the teachers observed their behaviour in classroom contexts. Thus achieving some equivalence in the ratings (Rios & Hambleton, 2016). Gliner et al. (2017) suggest that if raters or contexts are different, then their correlations can be evaluated based on Cohen's (1988) guidelines: $r = 0.1$ correlation is weak; $r = 0.3$ modest; $r = 0.5$ moderate; $r = 0.8$ strong and $r > 0.8$ very strong. This suggests that the correlation coefficient (effect size) of the parents' and teachers' ratings ranged from modest to strong (Table 18).

Table 18

Comparisons of Parents' and Teachers' Ratings of Typically Developing 5- to 11-year-old Children on the Preschool DMQ 18

Scale	Items	Teachers (n=50)		Parents (n=50)		*t*	*p*	*r*
		M	*SD*	*M*	*SD*			
Persistence scales								
Cognitive/object	5	3.9	.50	3.90	.63	-.289	.774	.28*
Gross Motor	5	3.7	.62	4.16	.53	-3.75	.000	.22
Social w. Adults	5	3.8	.52	3.73	.56	1.67	.101	.29*
Social w. Children	6	3.9	.41	4.16	.43	-2.86	.006	.39**
Total persistence	21	3.8	.41	3.99	.39	1.56	.125	.33*
Expressive scales								
Mastery Pleasure	5	4.2	.64	4.32	.43	-1.08	.287	.29*
Negative Reactions	8	3.7	.66	3.82	.47	-1.05	.30	.40**
Frustration/anger	4	4.0	.80	3.97	.64	.35	.726	.40**
Sadness/shame	4	3.6	.60	3.67	.57	-.65	.518	.56**

Note. *$p < 0.05$ **$p < 0.01$

Age and Gender Comparison

According to the National Early Childhood Education Policy (2017), children join pre-primary I at 4-years-old and pre-primary II at five years old. The DMQ 18 preschool version was created mainly for 3-7 year-olds (Józsa & Morgan, 2015). We, therefore, tested whether there was a significant difference between the children below seven years and above seven years in preschool classrooms. The cognitive persistence

scale was insignificant, but all the other scales were significant (Table 19). The older children seem less motivated based on the preschool teachers' ratings. We determined whether there was a significant difference between the Kenyan sample and the preliminary norms of typically developing children from the other 8 studies. The results showed that there was a significant difference in all the scales except the general competency scale. On average Kenyan children were rated highly on most scales (Table 19).

Table 19

Comparisons of below Seven years and over Seven years old Teachers' Ratings of Typically Developing Children on the Preschool DMQ 18

Scale	Items	Below 7 (n=270)		Prel-norms (n=2406)*		Above 7 (n=127)		t^1	t^2
		M	*SD*	*M*	*SD*	*M*	*SD*		
Persistence scales									
Cognitive/object	5	4.07	0.70	3.88	0.79	3.84	.57	1.78	3.79**
Gross Motor	5	3.87	0.72	3.78	0.88	3.26	.82	4.40**	2.88**
Social w. Adults	5	3.72	0.69	3.62	0.82	2.99	.82	5.60**	1.93*
Social w. Children	6	4.02	0.64	3.84	0.72	3.54	.62	3.87**	3.94**
Expressive scales									
Mastery Pleasure	5	4.38	0.70	4.24	0.65	3.70	.86	4.96**	3.33**
Negative Reactions	8	3.64	0.99	3.38	0.76	2.88	.89	3.98**	5.15**
General Competence	5	3.72	0.80	3.64	0.83	2.92	.80	5.19**	1.51

Note. Preliminary norm was calculated from 8 studies of children growing typically, Józsa and Morgan (2015); Shaoli et al. (2019); Özbey (2018a,b), Türkmen & Özbey (2018), Özbey & Aktemur Gürler (2019), Gözübüyük and Özbey (2019), Köyceğiz and Özbey (2019); countries. Each country was weighted equally for the norm mean (M); we used the usual standard deviation (SD) formula. Morgan et al., 2020; t^1 - the difference between children at the right age in preschool II and above the normative age; t^2 - the difference between the Kenyan children in preschool II and the preliminary norms from 8 countries
*$p < 0.05$ **$p < 0.01$

Further, we also tested if there is a significant difference between boys and girls. Again, the *t*-test results showed no significant difference between boys and girls across all the subscales.

6.4.4 Discussion

The results of the CFA provided more evidence for the factor structure of the Preschool DMQ 18. The analysis revealed that the general competency scale had low factor loadings and resulted in model misspecification. We, therefore, removed the general competency scale to achieve a model fit. The resulting model had six scales

with excellent psychometric properties, and it was meaningful (according to our data) within the Kenyan context. Similar studies by Morgan et al. (2017) and Józsa and Morgan (2015), using ratings from parents of Hungarian and Taiwanese children, also did not include the general competence scale because they did not consider it to be part of mastery motivation when determining the factor structure of the Preschool DMQ 18 in their respective countries. However, Salavati et al. (2018) computed a CFA of all the subscales with parent ratings of Persian children with Cerebral Palsy and achieved a good model fit. The final Preschool Dimensions of Motivation Questionnaire 18 questionnaire retained cognitive persistence (five items), social persistence with adults (five items), social persistence with children (six items), gross motor persistence (five items), mastery pleasure (five items) and adverse reactions (eight items).

The subscales of the Swahili Preschool Dimensions of Motivation Questionnaire 18 had internal consistency reliability values above the cut-off ranging from .77 to .91. These reliability values were also seen in other translations of the DMQ, such as the Bangla version from Bangladesh .83 to .94 (Shaoli et al., 2019), the Hungarian .79 to .94 (Józsa & Morgan, 2015), .84 to .91 for the Turkish translation (Özbey & Daglioglu, 2017) and .41 to .80 for the Persian version (Salavati et al., 2018). In addition, the Swahili DMQ had Parallel forms reliability of .76, which was slightly lower than that of the Bangla version ($r = .85$, $N = 20$, $p < 0.01$) but acceptable (Shaoli et al., 2019).

The Swahili version of test-retest reliability was .87, similar to the Bangla version of .88 (Shaoli et al., 2019) and slightly lower than the Persian version of .94 (Salavati et al., 2018). The current study also provided further information about the different types of raters. The teachers rated their preschool children more highly than the parents, and the test-retest reliabilities rated by teachers were also acceptable for all scales. Divergent validity was ascertained using the Fornell-Larcker (1981) criterion, and all values had a lower correlation than the square root of their AVE. Construct (convergent, divergent, criterion) validity was confirmed, indicating that the translation of the Preschool Dimensions of Motivation Questionnaire 18 was good. The correlation of parents' and teachers' ratings ranged from modest to strong and provided further evidence of convergent validity (Barrett et al., 2020).

Parent-teacher comparisons of raters were computed using paired sample *t*-tests. The results showed that Kenyan teachers rated children higher than the parents of the same typically developing children. We also compared the Kenyan ratings with other

ratings from other 8 studies of typically growing children(Morgan et al., 2020). Again, there were significant differences in the scales except for general competencies. Generally, Kenyan teachers rated the children higher than other teachers in other studies. These high ratings could be because Kenyan teachers imagined higher motivation as equivalent to higher achievement.

Nevertheless, other reasons affect the ratings of mastery motivation, such as parent education, children with and without developmental delays, and age and gender differences (Morgan et al., 2017). Although gender is one factor that affects the rating of mastery motivation, there were no gender differences in this sample. We also compared children above and below seven years to establish whether they were significantly different. Older children are less motivated in preschool than younger ones. It is only the cognitive persistence scale that was not significantly different. Maybe the older children are not getting enough challenge in preschools, and therefore they show less motivation and less mastery pleasure. This suggests that preschool classes may not be the best alternative for older children.

6.4.5 Summary and Conclusion

The translated Swahili version of the Preschool Dimensions of Motivation Questionnaire 18 was reliable and valid for assessing the mastery motivation of Swahili-speaking participants(see Appendix 4 for a sample questionnaire). Furthermore, given that parents and caregivers are close to their children and have access to much information regarding their children's behaviour and development, those who cannot understand English now have an opportunity to use the Swahili version. Similarly, those acquainted with English can now use the English version, as demonstrated by the parallel form's reliability results. Thus, these two versions will provide inclusivity in mastery motivation research in Kenya's Swahili and English-speaking communities.

6.5 Study 4: The Childhood Executive Functioning Inventory (CHEXI): Psychometric Properties and Association with Academic Performance in Kenyan First Graders

6.5.0 Introduction

Authors have defined executive functions as a set of domain-general cognitive processes that support problem-solving, self-management, and goal-directed behaviour (Camerota et al., 2018). However, most Executive Function studies have been done in Western countries (Nakamichi et al., 2021), and very little is known about executive functions in sub-Saharan countries (Willoughby et al., 2019). Studies support that children with low SES have poor Executive Function skills (Hackman et al., 2015; Obradović & Willoughby, 2019). However, a study by Cook et al. (2019) that compared children from low and middle as well as high income SES in Australia and South Africa reported that the subsample from highly disadvantaged children from low SES outperformed in two out of three executive functionss the children from middle and high income in Australia. This indicates a possibility of executive functions protective and promotion practices in Low and Middle-Income Countries (LMIC). Nonetheless, more than 250 million children in LMIC, especially in sub-Saharan Africa, suffer from environmental deprivation, malnutrition and illness that affect their cognitive development (Lu et al., 2016; Obradović & Willoughby, 2019; Willoughby et al. 2019). Moreover, executive functions depend on the prefrontal cortex, which is vulnerable to environmental factors such as poverty, loneliness and stress (Arnsten, 2015; Casey et al., 2018; Noble et al., 2012) rampant in LMICs. Additionally, most executive functions assessment in LMICs has used laboratory measures (see Obradović & Willoughby, 2019 for a review), although there is demand for Executive Function ratings by teachers, parents, and other researchers (Camerota et al., 2018). We are not aware of another study that has assessed executive functions using ratings in Kenya and examined its association with academic performance.

6.5.1 Objectives of the Study

To assess executive functions, most researchers and policymakers from LMIC countries have borrowed measures from developed countries, although situations may differ from high-income to low-income countries, raising validity concerns (Betancur et al., 2021). Therefore, the study aimed to answer the following research questions;

RQ1/S2: Determine the factor structure of the Childhood Executive Functioning Inventory (CHEXI: Thorell & Nyberg, 2008) in the Kenyan context?

RQ2/S2 Determine measurement invariance of the CHEXI based on gender?

RQ3/S2 Determine whether there are significant differences in executive function skills based on gender, age and type of school the child attended?

RQ4/S2 Examine the association of Executive Functions and academic performance among Kenyan First Graders?

RQ5/S2 Does Executive Functions influence academic performance among first graders in the Kenyan Context?

6.5.2 Method

Participants

After getting the Institutional ethics review approval and authority to conduct the study in Kenya, we recruited 526 grade one pupils aged between 6 to 11 years (M=7.8 years, SD=1.16; 259 boys, 267 girls) in 27 schools. All schools consented to participate in this study. A total of 33 teachers assisted by three research assistants rated the pupils and administered direct assessment tests. At the time of the study, all pupils were typically normal. Measures of parental education indicated that 66% had completed primary education, 23% secondary, 9% diploma, and 2% had university degrees. The parents were mostly subsistence farmers, and others engaged in small businesses.

Additionally, according to the Constitution, Kenya has 42 different languages, but English and Kiswahili are the official languages (Republic of Kenya, 2010). Therefore, English is used as a medium of instruction for all classes and subjects except Kiswahili. For this reason, all teachers are well versed in English and competent as independent users of the language. On the other hand, Kiswahili is mainly used during informal discussions between individuals of different tribes or those not fluent in English. Nonetheless, all teachers are fluent and competent in both English and Kiswahili languages.

The Childhood Executive Functioning Inventory (CHEXI)

The CHEXI (Thorell & Nyberg, 2008) was developed based on Barkley's (1997) hybrid model that identified working memory, inhibition and regulation as the major deficits in children with ADHD. The CHEXI English version is a 24-item questionnaire that is simpler to fill out and freely available online at the CHEXI website. It has four priori subscales: working memory (11 items), *e.g.,* "*Has difficulty understanding verbal instructions unless he/she is also shown how to do something".* Inhibition has (6 items), *e.g.,* "*Has difficulty holding back his/her activity despite being told to do so* and planning (4 items), *e.g.,* "*Has difficulty with task or activities that involve several steps"* Regulation is the last with five items, *e.g.,* "*Seldom seems to be able to motivate him-herself to do something that he/she does not want to do*". For each statement, the child is rated from 1- definitely not true to 5 definitely true. When scoring the CHEXI, subscale 1, working memory is represented by the total scores of items 1, 3, 6, 7, 9, 19, 21, 23, 24; subscale 2, planning 12, 14, 17, 20; subscale 3 regulation, 2, 4, 8, 11, 15 and subscale 4, inhibition 5, 10, 13, 16, 18, 22. Participants with Executive Function difficulties will have high scores (Camerota et al., 2018). Despite the four subscales, factor analysis in kindergarten children identified two factors, working memory (including working memory and planning) and inhibition (including inhibition and regulation). This signifies that working memory and inhibition as the most basic Executive Functions (Catale et al., 2015; Miyake et al., 2000). For this study, the CHEXI English version was adopted as it is.

Academic Performance

A standardized test developed and validated by the Kenya National Examination Council in partnership with World Bank and Global Partnership for Education was used to assess the academic performance of grade 1 pupils after the transition to grade one. In Kiswahili, the test assessed comprehension (12 items), language use (13 items) and writing (10 items). In mathematics, the examination assessed shape identification (4 items), number naming, producing sets (3 items), quantity discrimination (4 items), putting together (addition) (2 items), take away (subtraction) (2 items), mental addition, and measurement (5 items). The English language test assessed dictation (2 items), language use (13 items), writing (10 items), and reading comprehension (10 items). All exam items were obtained from grade one textbooks approved by the Kenya Institute of Education.

Procedure

We stratified primary schools into two types, private and public, in a large coastal county in Kenya to ensure each category of schools is represented proportionately in the sample. For public schools, we randomly selected 15 schools and 12 in the private schools' category. Using the class nominal register, we used systematic random sampling to select 20 pupils while counterbalancing gender. For example, if a class had 60 pupils, every third pupil on the list became part of the sample. Following Fajrianthi et al. (2020) guidelines for the adaptation of questionnaires, teachers assisted by three research assistants rated the pupils in a school setting for executive functions skills using the CHEXI (Thorell & Nyberg, 2008). The teachers filled out the CHEXI in English. The direct assessment tests were administered two weeks after the executive functions ratings according to the Ministry of Education protocols on COVID-19 prevention. In all 27 schools, the direct assessments were administered in three days, starting with Mathematics, English and later Kiswahili, following the Governments examination calendar and guidelines. In strict adherence to the marking scheme, each item was awarded 1 if correctly and 0 otherwise. Total scores were calculated individually per subtest. In the third week, the marks were collated and linearly transformed to percentage points per subject, Maths x/20 x 100pp, English and Kiswahili x/35 x 100pp.

Analytic Plan

Data analysis employed two main steps. Firstly, to obtain reliabilities, means, standard deviations and correlations, IBM SPSS 23 was used. The internal consistency reliability (Crbα; Chronbach alpha) and composite reliabilities (CR; Raykov, 1997) were used to judge the instrument's reliability. Values above 0.70 indicated good reliabilities (Hair et al., 2014). Secondly, to establish validity, the exploratory factor analysis was computed. The data set was checked to see if the variable system was appropriate for factor analysis using the Kaiser-Meyer-Olkin (KMO) index (Kaiser, 1970). To establish the validity of the CHEXI, Confirmatory Factor Analysis (CFA) was computed using AMOS version 24. The following model fit indices, and their cut off was adopted to assess the model fit: Root Mean Square Error of Approximation (RMSEA) < 0.08, Tucker-Lewis Index (TLI) ≥ 0.90, and CFI ≥ 0.90) (Schreiber et al., 2006; Schumacker & Lomax, 2016). To determine the predictive ability of the CHEXI multiple regression was employed in IBM SPSS 23.

6.5.3 Results

Descriptive Statistics and Validity

Descriptive Statistics

The mean for all the items in the CHEXI scale ranged from 2.79 (*SD* = 0.89) to 3.35 (*SD* =1.04), with an overall mean of 2.91 (*SD* = 1.06).

Content Validity

To establish content validity, the internal structure of CHEXI was tested by EFA using Principal Component Analysis with Varimax rotation. The KMO index was high at .96, with a significant score on Bartlett's Test of Sphericity (χ^2 = 8353.51, p < .0001), indicating that the data is reliable and suitable for factor analysis. Initial analysis identified three factors, with Eigenvalues above 1 accounting for 62.03% of the variance. However, on close inspection of the Eigenvalues, the scree plot showed that it broke after the second component. Based on this, we retained the two-factor structure of CHEXI.

Construct Validity

To examine the goodness of fit of the two-factor solution of the CHEXI (Thorell & Nyberg, 2008), with no missing data, CFA with Maximum Likelihood estimation was used. Initially, a four-factor model was identified with acceptable model indices (Table 6.7). However, discriminant validity was poor because AVE's square root for working memory was less than its correlation with planning, regulation, and inhibition. Also, working memory and planning were statistically indistinguishable and highly correlated, r = .95. Similarly, also inhibition and regulation had a high correlation, r = .79. We, therefore, collapsed the four-factor model into two; working memory and planning put together and inhibition and regulation, also together similar to Camerota et al. (2018) and Józsa and Józsa (2020). This model with adjustment of the modification indices fitted well with a χ^2 (3239.40) = 1090, p < .001, CMIN / DF = 2.972, CFI = 0.946, SRMR = 0.043, RMSEA = 0.027 which is an excellent model. Since all the items had variances above 30%, this also suggests good reliability (Bollen, 1989). This model's factor loading was also above the acceptable factor weight, confirming convergent validity (Hair et al., 2014). Figure 14 shows the measurement model of the two-factor structure. As figure 14 shows, there was a high correlation between inhibition and working memory (r = 0.85), suggesting a one-factor model. However, compared to a two-factor model, the model fit indices fit the data better (Table 19) model 3.

Figure 14

The measurement model of the CHEXI two factor structure

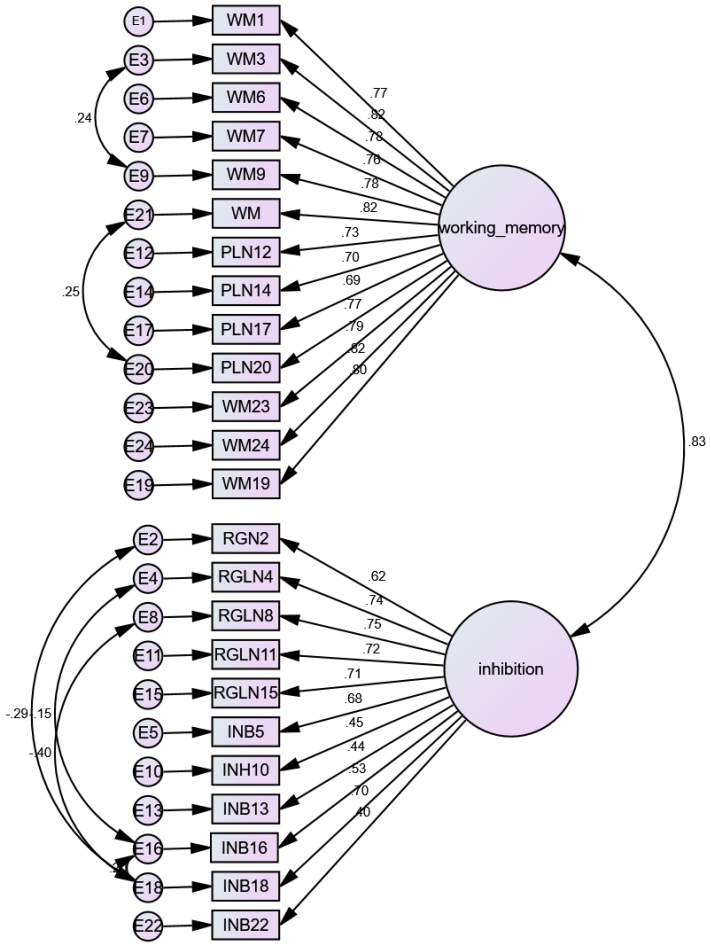


Table 20

Model Fit Indices for CHEXI Factor Structure

Model	Model description	CMIN/DF	SRMR	CFI	TLI	RMSEA
	CHEXI factors					
1	4 Factors (WM, PLAN, INH, REG)	3.227	.042	.938	.930	.065
2	2 Factors (WM, INH)	3.864	.046	.914	.930	.064
3	**2 Factors (WM, INH) w/correlated errors**	**2.972**	**.041**	**.950**	**.940**	**.027**
4	1 Factor model	3.354	.040	.920	.910	.026

Note. CFI=comparative fit index; INH=inhibition; PLAN=planning; REG=regulation; RMSEA=root mean square error of approximation; SRMR =standardized root mean square residual; TLI=Tucker Lewis Index; WM=working memory

However, factor loadings for item 10, *"Gets overly excited when something special is going to happen (e.g., going on a field trip, going to a party)"* and 13, "*Has difficulty holding back his/her activity despite being told to do"* were low at 4.37 and 4.39, respectively (Table 20) but above the threshold. Maybe item 10 was low since teachers could not draw current examples of children engaged in parties or field trips due to the current pandemic.

Table 21

Standardized Factor Loadings of the CHEXI Items Rated by Teachers

	Items	A priori scale	Factor loadings
	Working memory		
1	Has difficulty remembering lengthy instructions	WM	.781
3	Seldom seems to be able to motivate him/herself to do things something that he/she does not want to do.	WM	.825
6	When asked to do several things, he/she only remembers the first or last	WM	.802
7	Has difficulty coming up with a different way to solving a problem when he/she gets stuck	WM	.771
9	Easily forget what he/she is asked to fetch	WM	.784
12	Has difficulty planning for an activity (e.g., remembering everything necessary for a field trip or things needed for school.)	PLAN	.738
14	Has difficulty carrying out activities that require several steps (e.g., for younger children, getting completely dressed without reminders; for older children, doing homework independently.)	PLAN	.710
17	Has difficulty telling a story about something that has happened so that others may easily understand	PLAN	.709
19	Has difficulty understanding verbal instruction unless he/she is also shown how to do something	WM	.817
20	Has difficulty with tasks or activities that involve several steps.	PLAN	.806
21	Has difficulty thinking ahead or learning from experience	WM	.833
23	Has difficulty doing things that require mental effort, such as counting backwards.	WM	.801
24	Has difficulty keeping things in mind while he/she is doing something else.	WM	.823

	Items	A priori scale	Factor loadings
	Inhibition		
2	Seldom seems to be able to motivate him/herself to do things something that he/she does not want to do.	REG	.610
4	Has difficulty following through on less appealing tasks unless he/she is promised a type of reward for doing so.	REG	.755
5	Has the tendency to do things without thinking of what could happen	INHIB	.681
8	When something needs to be done, he/she often distracted by something more appealing.	REG	.768
10	Gets overly excited when something special is going to happen (e.g., going on a field trip, going to a party)	INHIB	.439
11	Has clear difficulties doing things he/she finds boring.	REG	.730
13	Has difficulty holding back his/her activity despite being told to do.	INHIB	.437
15	In order to be able to concentrate, he/she must find the task appealing	REG	.726
16	Has difficulty refraining from smiling or laughing in a situation where it is inappropriate	INHIB	.504
18	Has difficulty stopping activity immediately upon being told to do so. For example, he/she need to jump a couple of extra time or play on a computer little bit longer after being told to stop.	INHIB	.674
22	Act in a wilder way compared to other children in the group (e.g., at a birthday party or during a group activity)	INHIB	.511

Note: WM=working memory; PLAN=planning; INHIB=inhibition; REG=regulation

Following the Fornel-Lacker criterion, 1981, the square root of 0.626 (AVE) is higher than the correlation between inhibition and working memory (r = .80), suggesting an acceptable discriminant (divergent) validity. Also, Construct Reliability (CR) for working memory was .93 and inhibition .90, all above .50, indicating good convergence validity (Hair et al., 2010).

Reliability

Internal consistency was computed for both working memory and inhibition subscales. Both scales have high reliabilities: working memory (α = .95); inhibition (α = .86). The total reliability of the CHEXI was .95. All these values were above the threshold of .70 (Gliner & Morgan, 2017).

Measurement Invariance of the CHEXI Across Gender

Measurement invariance evaluates the psychometric equivalence of a construct across groups before testing means differences due to changes over time (Putnick & Bornstein, 2016). Such groups include child genders (Hong et al., 2003), cultural groups (Senese et al., 2012) and across time (Widaman, 2010). We, therefore, tested whether the CHEXI measures the same construct across gender, boys and girls. To assess measurement invariance, we computed a series of competing models from configural invariance through metric invariance to scalar invariance (Putnick & Bornstein, 2016) using AMOS 24. Finally, following Cheung and Rensvold (2002), a model demonstrates measurement invariance if the $\Delta CFI \leq 0.01$ (Table 22).

Table 22

Measurement Invariance of the CHEXI Across Gender

Model	X^2 (*df*)	CFI	RMSEA (90%CI)	SRMR	Model comp	ΔX^2 (Δdf)	ΔCFI	ΔRMSEA	ΔSRMR
M1 Configural invariance	1309.5 (490)	.903	0.056 (0.053-0.060)	.058	-	-	-	-	-
M2 Metric Invariance	1328.5 (512)	.903	0.055 (0.052-0.059)	.069	M1	19.0 (22)	0	-.001	.011
M3 Residual Invariance	1350 (534)	.903	0.054 (0.050-0.058)	.067	M2	22.15 (22)	0	.001	-.002
M4 Scalar invariance	1626 (558)	.894	0.060 (0.057-0.064)	.080	M3	276 (24)	0.009	.006	.020

Note. $N = 526$; group 1- Boys $n = 258$; group 2-Girls $n = 268$; $^*p \leq .05$; $^{**}p \leq .01$

School type, Gender and Age differences

After transitioning to grade one, we assessed the children's executive functions skills based on school type, gender, and age differences (Table 21). Schools were classified based on management and ownership into public and private schools. The Ministry of Education manages the public schools on behalf of the government, and they are free, while individuals manage private schools as a business and charge fees. Independent-samples *t*-tests showed that there was a significant difference in the total executive functions scores for public ($M = 70.23$, $SD = 17.0$) and private schools ($M = 61.20$, $SD = 16.30$), $t\ (524) = 6.13$ $p < .001$), Cohen $d = 0.53$. Note that the higher the executive functions score assessed by CHEXI, the higher the executive functions difficulties (Camerota et al., 2018). Additionally, private schools' academic performance was much higher than public schools

(Table 22). Nonetheless, there was no significant differences in gender; scores for boys (*M* = 67.1, *SD* = 18.0) and girls (*M* = 65.8, *SD* = 16.6); *t* (524) = 0.862 *p* = .389, *d* = 0.07 in both type of schools.

Table 23

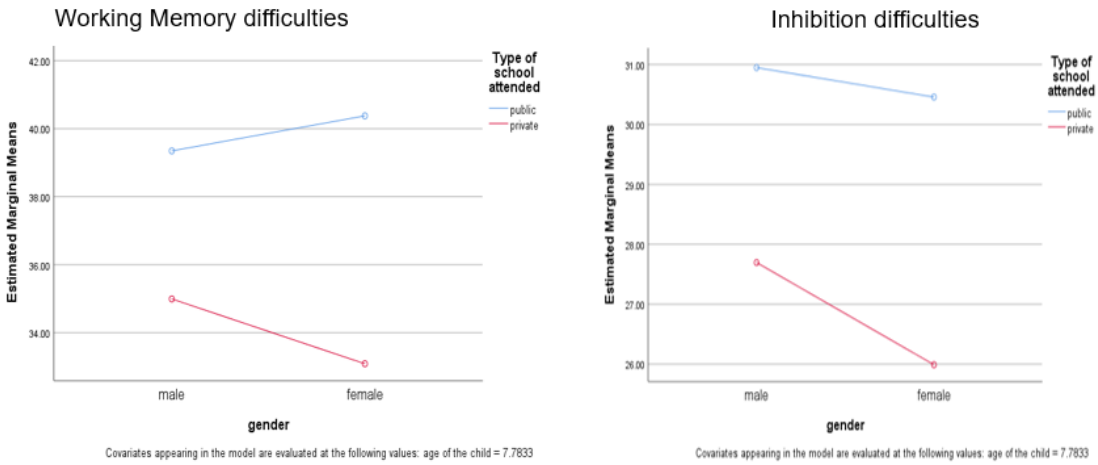
Means and Standard Deviations for CHEXI Ratings for Each Type of School

	Public school		Private school	
	Boys	Girls	Boys	Girls
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Background variables				
Gender (n)	156	149	102	119
Age (years)	8.04(1.24)	7.80(1.07)	7.60(1.22)	7.59(1.04)
Executive Functions Skills				
Working memory	38.88(11.20)	40.35(10.53)	35.33(12.44)	33.44(10.26)
Inhibition	30.81(7.63)	30.45(6.84)	27.79(6.47)	26.09(5.33)
Total Executive Functions	69.69(17.51)	70.80(16.41)	63.13(18.02)	59.54(14.54)
Academic performance				
Math	62.98(19.90)	60.62(19.31)	75.25(15.24)	77.16(14.93)
English	50.42(21.22)	49.84(19.78)	60.89(23.46)	66.63(22.93)
Kiswahili	52.40(22.77)	52.31(22.55)	61.90(24.29)	67.31(23.20)
Mean of 3 subjects	55.27(18.17)	54.26(17.09)	66.01(17.49)	70.37(17.58)

We tested if executive functions are significantly different by age among the first graders. To achieve this, we classified the students into three groups based on their ages: 5-6 (*n* = 51), 7-8 (*n* = 371), and above 9 (*n* = 103). Analysis of variance (ANOVA) showed that there was a significant difference among the different age groups in the same class, total executive functions (*F* = 5.919, *p* < .001). Post hoc analysis using Bonferroni indicated a significant difference between 5 - 6 and 7- 8 age groups *p* < .001 but not between 7- 8 and above 9 age groups *p* = .127. Consequently, 5-6 age group had the highest executive functions difficulty (*M* = 72.75, *SD* = 18.7), followed by 7-8 (*M* = 66.60, *SD* = 16.75) and lastly above 9 (*M* = 62.74, *SD* = 17.51) age category. Since there are significant age differences between public and private schools, we treated age as a covariate to examine the differences in executive functions between public and private schools.

Figure 15

Comparison of Working Memory and Inhibition Difficulties in Public and Private Schools



Association of Executive Function and Academic Performance

We also investigated whether there is an association between executive functions and academic performance (Table 24). The results indicated that there was a moderate negative correlation of Math and working memory (r = - .28, p < .001), English (r = - .41, p < .001), and Kiswahili (r = -.35, p <.001). For inhibition Math (r =-.318, p < 0.001), English (r = -.34, p < .001), and Kiswahili (r = -.28, p < .001) were also negatively correlated. Further, total executive functions had a moderate and significant negative correlation with academic performance (r = -.417, p < .001). Therefore, on average students who had high executive functions difficulties had low scores in academic performance (Table 24).

Table 24

Bivariate Correlations of Executive Functions Difficulties and Academic Performance

		1	2	3	4	5	6	7	8	9
1	Age									
2	Sex	-.069								
3	Type of sch.	-.140**	.049							
4	Math	-.090*	.004	.372**						
5	English	.064	.060	.301**	.548**					
6	Kiswahili	-.013	.059	.257**	.501**	.735**				
7	Acad. Ach.	-.010	.050	.356**	.772**	.899**	.889**			
8	Inhibition	-.047	-.079	-.266**	-.318**	-.335**	-.281**	-.362**		
9	WMemory	-.154**	-.009	-.229**	-.279**	-.414**	-.352**	-.411**	.757**	
10	Total EF	-.121**	-.038	-.259**	-.312**	-.408**	-.346**	-.417**	.903**	.965**

Note. Type of Sch. – Type of school the child attended, either public or private school; Acad. Ach- Academic Performance is the average of Math, English and Kiswahili scores; WMemory – Working Memory; Total EF – the sum of working memory and inhibition.

*. p<.05;**. p<.001;

We also determined the predictive ability of the CHEXI. The linear regression results indicated that total executive functions explained a significant proportion of variance in academic performance score, $R^2 = .17$, F (1, 525) =110.01, $p < .001$. The regression coefficient ($\beta = -.46$) indicated that an increase in one real Executive Function difficulties scores corresponded to a decrease in the academic performance score by 0.46 points.

6.5.4 Discussion

Executive Functions assessment has a huge application in education and clinical studies. For this reason, measuring executive functions is gaining much attention both in Kenya and internationally. Most tools assessing executive functions have used performance-based assessments that require trained examiners to administer. Such examiners are not available in most LMICs (Willoughby et al., 2019). Therefore, a good, reliable and affordable tool that is easy to administer and interpret is appropriate for LMIC regions. Although the original intention of the CHEXI was to assess Executive Function difficulties among children and youth for educational purposes, new evidence has established that the CHEXI can also diagnose children who are at risk of getting ADHD (Camerota et al., 2018). Additionally, CHEXI has been validated in other cultures, including Hungary (Józsa & Józsa, 2020), the US (Camerota et al., 2018), France (Catale et al., 2013), Belgium and Sweden (Catale, Meumelans, & Thorell, 2015) and Turkey and Portugal, (Thorell & Catale, 2014). The current adaptation adds to the list of already existing validations. The Kenyan sample's factor structure had a high KMO index of .96, signifying a reliable factor structure. The final factor structure of the Kenyan adaptation of the CHEXI retained a two-factor model: working memory and planning combined, and regulation and inhibition also combined, similar to Camerota et al. (2018), Catale et al. (2013), Thorell and Nyberg (2008). Moreover, the Kenyan version had a variance of 62%, explaining the factor structure, which was comparable to the Hungarian version of 61% (Józsa & Józsa, 2020). These variances are higher than the original development by Thorell and Nyberg (2008) of 41%. Regarding reliability, internal consistency and construct reliability values were above the threshold of .60 (Gliner et al., 2017), indicating that the CHEXI was reliable for the Kenyan sample. Similar reliability values were also reported in the Hungarian adaptation. We also determined the measurement invariance of the CHEXI across gender (boys vs girls) in the Kenyan context. The CHEXI demonstrated a strong invariance like the US version (Camerota et al., 2018). Further, executive functions assessed with the CHEXI significantly correlated with academic

performance, similar to Thorell and Nyberg (2008). This indicates the predictive validity of the CHEXI (Thorell et al., 2013). Indeed, these results support studies claiming that executive functions are a significant predictor of academic performance (*e.g.*, Christopher, 2012; Vandenbroucke et al., 2017). Other studies have reported that executive functions are related to academic performance because it affects the learners' motivational and affective attitudes toward learning (*e.g.*, Sung & Wickrama, 2018). Despite the grade one children being peers in the same class, their executive functions were significantly different by age and school type but not by gender. There are several reasons children in private schools in Kenya outperform children from public schools in Executive Function development. Firstly, the teacher-student ratio is highly in favour of private schools (1:24) against public schools (1:53) in urban areas and much higher in rural areas (Republic of Kenya, 2019). Fewer students per teacher and a class with essential teaching resources enhance a warm teacher-child relationship devoid of stress, anxiety and fear. According to sociological and attachment theory, this relationship determines the level of engagement, resulting in better approaches to learning, socio-emotional adjustment, and cognitive skills development (Ainsworth, 1989; Bronfenbrenner & Morris, 2006). Secondly, most parents who can afford private schools have a higher SES than those taking their children to public schools. Higher SES has also been shown to support executive functions' enhancement due to parental scaffolding and quality of life (Brown & Landgraf, 2010; Casey et al., 2018). This is in line with calls for individualized intervention strategies to enhance school readiness (Barrett et al., 2017). Strategies to improve executive functions include cognitive training programs (Aksayli et al., 2019), classroom curricula that target executive functions (Solomon et al., 2018), high-quality instructional practices and classroom management procedures (Bierman et al., 2008; Raver et al., 2011). Others with big impacts on executive functions in children include martial arts, mindfulness and Montessori teaching (Diamond & Ling, 2016). Moreover, effective teaching practices, curriculum support and fostering better approaches to learning are useful in closing the gap among at-risk children (Sung & Wickrama, 2018). Duncan et al. (2018) reported that executive functions and approaches to learning are similar or related. Others also indicated that executive functions and mastery motivation are important components of approaches to learning (*e.g.*, Berhenke et al., 2011; Buek, 2019; Józsa et al., 2017). To assess mastery motivation to complement executive functions during the assessment of approaches to learning, the preschool Dimension of Mastery Questionnaire (DMQ) has also been validated for the Kenyan sample (Amukune et al., 2021). Despite the unique strength of combining direct assessments of school performance and teachers'

executive functions ratings, this study had some limitations. Parents also have a lot of information regarding their children, especially at home. Similar ratings by parents could have provided an alternative source of information. However, Thorell and Nyburg's (2008) study indicated that the ratings of both parents and teachers discharged similar functions. Therefore, there is a need to translate the English version of CHEXI to the Kiswahili language well understood by parents who are not well versed in English. Further, CHEXI is widely accessible and easy to use, but it does not incorporate established normative data for comparison by examiners to determine whether their samples exceed clinical standards. This is the greatest advantage of the BRIEF since it has established normative data based on clinical samples of children with ADHD. However, there are some indications from the study by Catale, Meumelans, and Thorell (2015) that the classification rates of the ADHD and control groups in Sweden and Belgium ranged between 88 and 94.

6.5.5 Conclusion

Given the significance of executive functions assessment, quick and effective methods must be devised, especially for the LMICs. The CHEXI demonstrated strong psychometric properties and is suitable for assessing executive function skills in Kenyan culture. Additionally, the two-factor structure tapping working memory with 13 items and inhibition with 11 items were retained, which is consistent with the literature (*e.g*., Camerota et al., 2018; Catale et al., 2013, Catale, Meumelans et al., 2015; Józsa & Józsa, 2020; Thorell & Catale, 2014). Therefore, a new validation of the CHEXI has joined this growing list. Further, the CHEXI has significant application in identifying children with Executive Function difficulties. This can help provide individualized intervention to children with poor academic performance due to difficulties in executive functions. Further, children of the 5-6 age category attending public schools had more significant Executive Function difficulties than their counterparts from private schools. Therefore, further research is needed to identify possible causes of poor Executive Function skills in public schools in the study area.

6.6 Study 5: Approaches to Learning: The Contribution of Mastery Motivation and Executive Functions to Academic Performance of First Graders

6.6.1 Introduction

Recently, studies have focused on the significance of character traits or non-academic skills such as motivation, executive functions, perseverance and mindset in predicting test scores, educational attainment and grades as a strategy to enhance school performance (Duckworth & Gross, 2014; Eskreis-Winkler et al., 2014; Ribner, 2020). Given the diversity of learning environments that children experience, some key questions arise. First, these individual traits contribute the most to academic success and school readiness (e.g., Ribner, 2020). Second, to account for individual differences in adaptation among learners, researchers have focused on motivation (MacTurk et al., 1995), self-regulation and persistence that support school success (Finch & Obradović, 2017). Indeed, several authors have identified both mastery motivation and executive functions as critical components of approaches to learning (e.g.,Barrett et al., 2017; Buek, 2019; Duncan et al., 2018; Józsa & Barrett, 2018). Third, Approaches to Learning refer to attributes that help children learn, such as enthusiasm, self-regulation, persistence, motivation, interest, flexibility, initiative, reflection, attentiveness, cooperation, and independence (e.g., Hyson 2008; Li et al., 2019; McDermott et al., 2012). Mastery motivation focuses on persistence when solving moderately challenging tasks and engagement with people and objects during learning (Busch-Rossnagel & Morgan, 2013). This is why mastery motivation is considered important in approaches to learning dimension of school readiness (Fantuzzo et al., 2004).

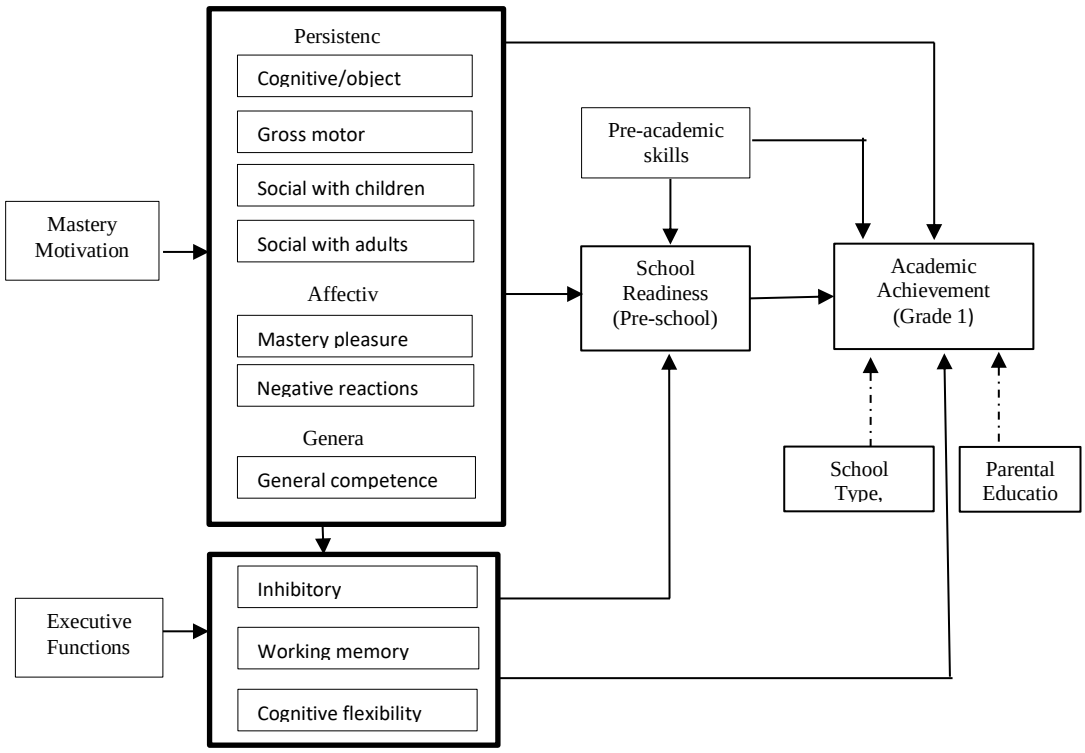
On the other hand, neuroimaging results have shown that executive function components are critical in learning(Sung & Wickrama, 2018) and are responsible for reflective learning and goal-directed problem solving (Zelazo, 2015). Furthermore, dimensions of approaches to learning such as effort control, attention span and cognitive persistence are positively associated with academic performance (Blair & Razza, 2007; García et al., 2016; Józsa & Molnar, 2013). Further, some studies have reported that student persistence can mediate academic performance and cognitive control in elementary school (Sung & Wickrama, 2018; Vitiello & Greenfield, 2017). However, more studies are needed to fully understand these associations (Józsa et al., 2017). Surprisingly, mastery motivation has received very little attention in school readiness literature (Józsa and Barrett, 2018). Moreover, studies examining cognitive control and

student persistence rarely combine them with motivation (Torgrimson et al., 2021). Authors have also observed a paucity of research on the associations between motivation and executive functions (Finch & Obradović, 2017) and mastery motivation as an intervening variable (MacPhee et al., 2018).

Further, some studies have reported that children from low socioeconomic status (SES) have a low mastery motivation, Approach to Learning and academic skills (Garcia, 2015). Why children from low SES have low mastery motivation is also not clear. Some researchers point at the economic stress that parents from low SES suffer that denies children diversity of options and role models (Turner & Johnson, 2003). Since mastery motivation is malleable (McDermott et al., 2014) and students with low SES benefit the most from such interventions (Drotar et al., 2009), strategies to improve mastery motivation and executive functions in early childhood might help close SES gaps, especially from at-risk children. To identify the role of mastery motivation and executive functions, we conceptualised the study as shown in figure 16 and followed the paths using path analysis.

Figure 16

Conceptual model of the relationship between Mastery Motivation, Executive Functions and Pre-academic Skills at Preschool and Academic Performance at Grade 1



Note. The dark boxes represent the intervening variable*;* the dotted arrows denote the extraneous variables

Both mastery motivation and executive functions are uniquely fundamental in a child's approaches to learning and school success. The developmental neurobiological model (Blair, 2002) posits that approaches to learning and executive functions are interdependent in promoting academic performance suggesting indirect effects on academic success through executive functions. mastery motivation leads to better Executive Function skills by allowing the learners to keep a goal in mind as they struggle to use various problem-solving strategies (Becker et al., 2019; Hauser-Cram et al., 2014; Pessoa, 2009). That is, mastery motivation promotes learning-related cognitive behaviours that enhance academic performance. Indeed some studies have indicated that preschool children's mastery motivation significantly predicted inhibition (Chang & Burns, 2005). Studies to establish if executive functions can mediate between academic performance and Approaches to Learning have been mixed. Although some authors have reported that working memory contributes to reading and mathematics across age groups(e.g., Christopher et al., 2012; Vandenbroucke et al., 2017), others did not find similar results (e.g., Blair & Razza, 2007; Lee et al. 2012). A study by Bohlmann and Downer (2016) showed no indirect effects of task engagement, one of the components of Approaches to Learning, on academic performance.

6.6.2 Objectives of the Study

Grounded in theory, this study theorized that both mastery motivation and executive functions are essential components of approaches to learning. Thus, it is hypothesized as follows (Figure 17);

Hypothesis I: Mastery Motivation has positive independent effects on academic performance (H1) (Józsa and Morgan, 2014; Mercader et al.,2017; Mokrova et al., 2013)

Hypothesis II: Executive Function skills directly affect academic performance (Foy & Mann, 2013; Cartwright, 2012; Kolkman et al., 2013).

Hypothesis III: Mastery Motivation directly affects Executive Functions skills (H3) (Becker et al., 2019; Hauser-Cram et al., 2014; Pessoa, 2009; Peterson & Welsh, 2014)

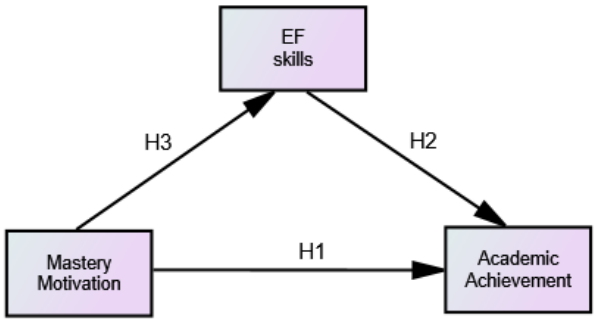
Hypothesis IV: Executive function skills mediate the relationship between Mastery Motivation and academic Achievement (Sung & Wickrama, 2018; Rash et al., 2016)

Hypothesis V: Children with low Mastery Motivation and great Executive Function difficulties will have a low academic achievement (Józsa & Molnar, 2013).

Hypothesis VI: There is a differing Effect of children's Executive Functions and Mastery Motivation on academic performance due to the nesting of children in public and private schools.

Figure 17

Theoretical Model of the Relations between Mastery Motivation, Executive Function skills and Academic Performance



6.6.3 Method

Sample and Settings

We collected data from 535 pupils studying in a large coastal county in Kenya. The children were enrolled in 33 classes selected using a stratified random sampling procedure from private (n = 12) and public schools (n = 15). Ten boys and ten girls were selected from each class using systematic sampling counterbalancing for gender. The children were aged from 6 to 11 years (M = 7.8 years, SD = 1.16, 259 boys/267 girls). The age range for grade 1 children in Kenya is 6–7 years; however, there was a significant number of children aged above 8 years (t (533) = −27.33, p < 0.001). This is due to deliberate government efforts to encourage children who had dropped out of school because of various challenges or setbacks to return to school. All of the children were of Kenyan origin and typically normal. Approximately 56% of the parents had had primary education and below. Moreover, most families were subsistence farmers, especially in rural schools.

Procedure

Ethical approval was granted by the National Council for Science and Technology in Kenya. The schools were stratified into public and private to ensure a balanced representation of both types. In each class, three children were randomly selected, counterbalancing for gender. A total of 33 teachers and 4 research assistants rated the children from their respective classrooms and schools. The direct assessment of academic performance was administered over three days following a government examination calendar in all the schools. A correct score was awarded 1, and a wrong one was awarded 0, and these were later transformed into a percentage score.

Measures

Demographic Variables

Data on the children's sex, age, type of school attended, parents, and parents' occupation were collected from the teachers and parents during recruitment. In Kenya, schools are generally classified as either private or public. Private individuals own private schools and charge a fee for tuition and meals, while public schools are free. In the study area, private kindergartens charge around USD 100 to USD 2000 per year, while they can charge up to USD 3000 per year at the high end. Parents who can afford the tuition prefer to take their children to private schools. Parents who prefer private schools earn between USD 600 and USD 1,200 per month, above the national average of USD 500 per month. Such parents may be willing to spend 40% of their income on educating their children (Zuilkowski et al., 2018). Therefore, the school type attended can indicate economic adversity status. All of the children who participated in the study had no special needs, and their parents had Kenyan nationality.

Mastery Motivation

Teachers completed the Dimension of Mastery Questionnaire 18 (DMQ 18; Morgan et al., 2020). The DMQ 18 School Version is a 41-item questionnaire with seven subscales. The first four scales relate to the instrumental (persistence) aspects of MM: (1) the object/cognitive persistence scale (six items), (2) the gross motor persistence scale (five items), (3) the social persistence with adults scale (six items), (4) and the social persistence with children/peers scale (six items). The other two scales assess the expressive/affective aspects of MM: (5) the mastery pleasure scale measures

the positive effect after completing or while working on a task with five items, and (6) the negative reactions scale has eight items focusing on sadness/shame and frustration/anger. Finally, there is a general competence scale with five items. A linear transformation was used to convert the mean to a range of 0 to 100 using a formula (x − 1) * 25, producing a percentage point (% *p*) value. Therefore, from 1 to 5, the percentage points changed as follows: 1 = 0% *p*, 2 = 25% *p*, 3 = 50% *p*, 4 = 75% *p*, and 5 = 100% *p* (Józsa et al. 2019). The cognitive scale had excellent internal reliability of 0.821, similar to that found by Amukune and Józsa (2021). The cognitive persistence scale for MM denotes the child's motivation to persist and master school-related and cognitive tasks (Józsa & Morgan, 2014). It also represents the strongest connection with school performance (Gilmore et al., 2003; Józsa & Molnár, 2013; Mokrova et al., 2013).

Executive Functions Skills

The CHEXI (Thorell & Nyberg, 2008) is a 24-item questionnaire that is freely available online. It has four subscales: working memory (11 items), inhibition (6 items), planning (4 items), and regulation (5 items). For each statement, the item is rated for the given child from 1 *definitely not true* to 5 *definitely true*. Participants with greater EF difficulty have higher scores (Camerota et al., 2018). Across the four subscales, factor analysis in kindergarten children identified two categories: working memory (working memory and planning), with 13 manifest variables, and inhibition (inhibition and regulation), with 11 variables. The CHEXI has been validated in many cultures, including Kenya (Amukune & Józsa, 2021), and it is found to have good reliability on the working memory scale (α = 0.954) and Inhibition α = 0.862. Overall, the CHEXI is a valuable screening tool for predicting academic difficulties (Thorell et al., 2013).

Academic Performance

A standardized test developed and validated by the Kenya National Examination Council in partnership with the Global Partnership for Education and the World Bank was used to assess the academic performance of grade 1 pupils during the second term. All items were obtained from grade 1 textbooks approved by the Kenya Institute of Curriculum Development. The exam tested three subject areas: mathematics, English, and Kiswahili (Swahili), an official national language. In Kiswahili, the test assessed comprehension (12 items), language use (13 items), and writing (10 items). In mathematics, the examination assessed shape identification (4 items), number

recognition, producing sets (3 items), quantity discrimination (4 items), putting together (addition) (2 items), take away (subtraction) (2 items), mental addition, and measurement (5 items); the English language test assessed dictation (2 items), language use (13 items), writing (10 items), and reading comprehension (10 items). In each item, students received a mark of one for each correct answer and a mark of zero for each incorrect one. The total marks per subject were converted into a percentage score.

Data Analysis Plan

Three strategies were adopted for data analysis. In the first strategy, we used confirmatory factor analysis (CFA) to test the measurement models of the CHEXI (Thorell & Nyberg, 2008) to construct the latent factors in Amos 24. In the second, path analysis in Amos was used to determine the independent direct and indirect effects of MF and EFs on academic performance. Age, sex, and type of school attended were controlled in the model. In the third strategy, a one-way analysis of variance (ANOVA) was used to identify significant differences between children with low MM and high EF skill difficulties and those with high MM and low EF skill difficulties. Using G*Power 3.1.9.4, it was found that the sample size was sufficiently large to yield a medium effect size at a power of 80%.

Hypothesis VI investigated the differences in academic performance due to the clustering effects of children nested in schools. We used Multi-level analysis to calculate linear mixed-effects models based on maximum likelihood estimations (Twisk, 2006). This approach was helpful due to the number of classrooms where the children were drawn. In total, 27 classes were nested from 27 different schools(each school one class), either public(n = 15) or private schools(n = 12). Level 1 variables: Total executive functions, COP and MP and academic performance as a dependent variable. Linear mixed-effects for total executive functions, COP and MP were calculated separately. Level 2 variables: In this multilevel analysis, schools were treated as level two variables. The type of school was also used as adversity for socio-economic status. We also used the significance of the unconditional model to determine whether there was evidence for substantial clustering within the schools, which was our level 2 unit (Heck et al., 2013).

6.6.4 Results

Descriptive Statistics

Descriptive statistics indicating the means, standard deviations and reliability of each scale are shown in Table 24. The age of the grade one children ranged from 6 to 13 years. The normative age expected for a grade one child in Kenya is between 6-7 years (Republic of Kenya, 2017). However, there were no significant differences between children aged 6-7 years and above eight years regarding their academic performance t (533) = 1.254, p = 0.21. Also, there were no significant differences between boys and girls on all predictive variables (All t values (533) < -1.096 p >.273). However, there was a significant difference between children attending public and private schools on all predictors (All t values (533) < -10.242 p < .001). We also compared the same cohort in preschool and grade 1. There was a general decline in mastery motivation across all the factors. We tested whether there was a significant difference between preschool and grade 1 ratings of mastery motivation. Results showed that there was a significant difference in all the scales except the gross motor and general competence scales. Furthermore, the reliability of the scales in the study variables was above the recommended threshold: cognitive persistence was 0.85, working memory was 0.95, and inhibition was 0.86.

Table 25

Means and Standard Deviation for Mastery Motivation from FOCUS tasks and Executive Function Difficulties

Variable	Preschool Mean(SD) (N = 207)	Grade 1 Mean(SD) (N =535)	Range	Reliability	*t*
Mastery Motivation					
Cognitive persistence	4.07(0.70)	3.43(0.78)	1-5	.85	10.31**
Gross motor persistence	3.87(0.72)	3.77(0.70)	1-5	.83	1.73
Social pers. with adults	3.72(0.69)	3.46(0.78)	1-5	.80	4.20**
Social pers. with children	4.02(0.64)	3.72(0.68)	1-5	.86	5.48**
Total Persistence		3.65(0.61)	1-5	.93	
Mastery pleasure	4.38(0.70)	3.76(0.69)	1-5	.80	10.93**
Negative reaction	3.64(0.99)	3.42(0.69)	1-5	.79	3.42**
General competence	3.72(0.80)	3.66(0.75)	1-5	.81	0.99
Executive Functions Difficulties					
Working Memory		37.36(11.28)	13-65	.95	
Inhibition		29.59(6.95)	10-61	.86	
Covariates					
Age		7.78(1.15)	6 - 13		
Child sex – 1- female		50.3%	1-2		
School type – 1- public school		58.3%	1-2		

Bivariate Correlations of the Study Variables

Children who had high total EF (working memory and inhibition) difficulties tended to have low academic performance scores in mathematics, English, and Kiswahili ($r = -.407$, $p < 0.01$). Moreover, those who had high cognitive persistence tended to have high academic performance ($r = .357$; $p < 0.01$) scores. Similar results were also noted for the type of school the child attended, which was positively correlated with academic performance ($r = .364$; $p < 0.01$). Furthermore, higher age was associated with lower working memory difficulties ($r = -0.15$, $p < 0.01$) but not inhibition. Total persistence is an aggregated measure of instrumental persistence of mastery motivation, and it consists of cognitive persistence, social persistence with children or peers, social persistence with adults, and gross motor persistence. High total persistence was also associated with high mathematics, English, and Kiswahili performance (Table 25).

Table 26

Zero-Order Correlations Between the Study Variables

		1	2	3	4	5	6	7	8	9	10	11	12
1	Age	-											
2	Sex	- 0.069	-										
3	School type	0.002	0.054	-									
4	Maths	- 0.095*	- 0.004	0.402**	-								
5	English	0.067	0.059	.0352**	0.540**	-							
6	Kiswahili	- 0.010	0.058	0.199**	0.493**	0.734**	-						
7	ACAD	- 0.010	0.047	0.364**	0.767**	0.898**	.888**	-					
8	COP	0.062	0.018	0.121**	0.238**	0.347**	.320**	0.357**	-				
9	MP	0.096*	- 0.012	0.223**	0.301**	0.415**	.377**	0.430**	0.547**	-			
10	TOTALPERS	0.077	0.031	0.200**	0.286**	0.410**	.347**	0.410**	0.777**	0.728**	-		
11	WMEM	-0.154**	- 0.004	-0.249**	-0.277**	-0.410**	-.349**	-0.408**	-0.329**	-0.501**	-0.499**	-	
12	Inhibition	-0.035	-0.090*	-0.308**	-0.306**	-0.315**	-.254**	-0.339**	-0.309**	-0.377**	-0.422**	0.739**	-
13	TOTAL EF	-0.116**	-0.039	-0.290**	-0.307**	-0.400**	-.334**	-0.407**	-0.343**	-0.484**	-0.501**	0.962**	0.895**

Note. *. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed). ACAD = Average of Math, English and Kiswahili scores; COP = Cognitive Persistence scale; MP = Mastery Pleasure; TOTALPERS = Average of COP, MP and Gross motor and Social persistence; WMEM = Working Memory; TOTAL EF = Sum of Working memory and Inhibition

Measurement Models

We used CFA to test the measurement models from the CHEXI (Thorell & Nyberg, 2008) and construct the latent factors in Amos 24. We utilized full maximum likelihood when testing the models with no missing values. The model fit indices were RMSEA and SRMR ≤ 0.06, CFI and TLI ≥ 0.90 (Hu & Bentler, 1999). The two-factor model fit the data well, with a CMIN/DF of 3.11, CFI = 0.91, SRMR = 0.043, and RMSEA = 0.063, similar to the original factor structure. Therefore, we reduced our data to two latent factors of working memory, with 13 manifest variables, and inhibition, with 11 variables. We also used CFA to determine latent factors of the DMQ 18. Six factors fit well with the data, CMIN/DF of 2.21, CFI = 0.921, SRMR = 0.041, and RMSEA = 0.062. The general competency scale did not fit well, and it was expunged from the data.

Principal Analyses

To evaluate our hypotheses, we carried out a series of model tests. We assumed that the COP and MP scales of MM would positively predict academic performance, especially for mathematics, English, and the Kiswahili language. We also hypothesized that EF difficulties would have a detrimental effect on academic performance. Table 26 shows the model fits of measurement models of EF difficulties (working memory and inhibition) with COP and MP alone and combined in one model. Acceptable model fit indices were obtained for COP and MP: RMSEA and SRMR ≤ 0.06, CFI and TLI ≥ 0.90.

Effects of Mastery Motivation and Executive Function skills on Academic Performance

Hypothesis I sought to determine whether the COP and MP scales of mastery motivation could predict academic performance. Hypothesis II focused on the predictive ability of EF skills on academic performance. The measurement model shows that two factors represented EF skills: inhibition and working memory. To test Hypothesis I, three models were developed. In the first instance, EF skills, COP, and academic performance were introduced into model fitness determination. Second, COP was replaced by MP, and in the third model, both COP and MP were fitted in one model, and fitness indices were computed (Table 26). Acceptable model fit indices were achieved when COP and MP were fitted in separate models and when both were fitted

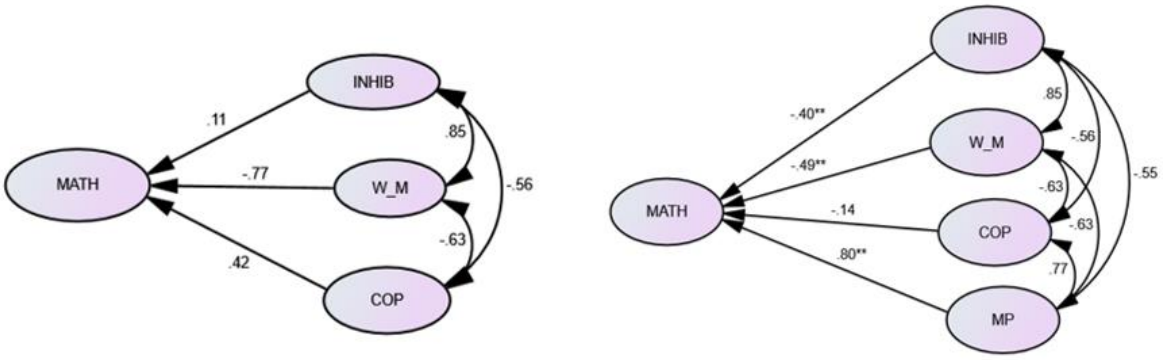
to the same model (Table 26). However, gross motor, social persistence, negative reactions, and general competence did not produce acceptable model fit indices, so they were dropped.

Math Performance

In the first model of COP, EF skills and mathematics performance fit the data well; COP (β = .42, p < .001), inhibition (β = −.11, p < .001), and working memory difficulties (β = −.77, p < .001) significantly predicted mathematics performance. In the second model, we replaced COP with MP; inhibition (β = −.62, p < .001) and working memory (β = −.13, p < .001) were significant negative predictors, and MP (β = .65, p < .001) was a positive predictor. Finally, in the third model, both COP and MP were fitted using the same model. Inhibition (β = −.40, p < .001) and working memory (β = −.49, p < .001) difficulties were significant negative predictors, and MP (β = .80, p < .001) significantly predicted mathematics performance (Figure 18). However, COP did not significantly predict mathematics performance in this model. Thus, an increase in 1SD COP and MP led to an increase of 0.42 *SD* and 0.65 *SD* in academic performance in models 1 and 2, respectively. Nevertheless, 1 *SD* working memory difficulties increase, which reduces academic performance by 0.77 *SD* and 0.13 *SD* in the COP and MP models, respectively.

Figure 18

Standardized Coefficients for the Math Model



Note. Latent constructs are shown in circles. INHIB = Inhibitory difficulties; COP = Cognitive Object Persistent of Mastery Motivation scale W_M = Working Memory difficulties; MATH = Math performance in grade 1; MP = Mastery Pleasure

Table 27

Model Fits of the Measurement Models

(a)	Working Memory, Inhibition and Cognitive persistence						
Model	χ^2	*Df*	RMSEA		CFI	TLI	SRMR
Math	1111.68	401	0.059	0.057-0.067	.924	.916	.044
English	1194.587	396	0.060	0.058-0.069	.916	.908	.046
Kiswahili	1178.338	394.00	0.061	0.058-0.071	.918	.909	.046
Total	1266.191	449.00	.0580	0.055-0.068	.920	.912	.049

(b)	Working memory, Inhibition and Mastery Pleasure						
Model	χ^2	*Df*	RMSEA		CFI	TLI	SRMR
Math	1201.286	390	0.062	0.058-0.066	0.915	0.905	0.063
English	1010.67	385	0.055	0.051-0.059	0.935	0.926	0.046
Kiswahili	1050.131	380	0.057	0.052-0.061	0.931	0.922	0.046
Total	1402.448	445	0.063	0.060-0.067	0.907	0.896	0.110

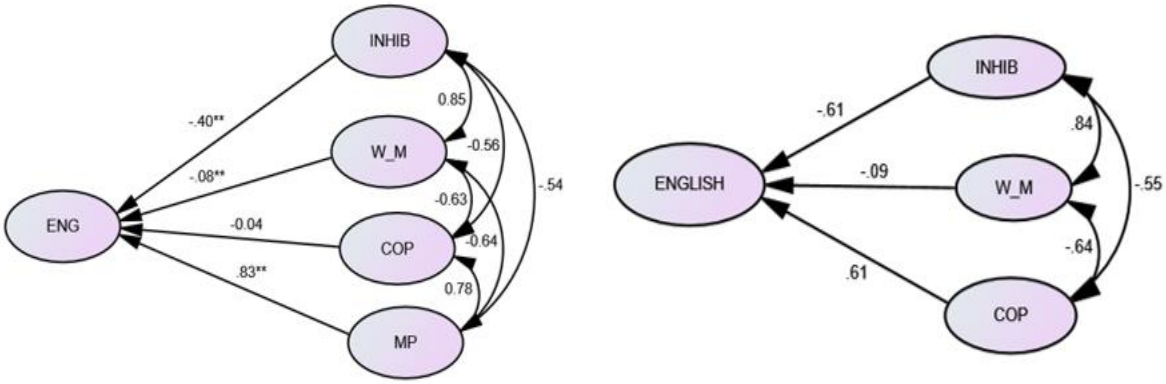
(c)	Working Memory, Inhibition, Cognitive persistence and Mastery pleasure combined						
Model	χ^2	*Df*	RMSEA	CI	CFI	TLI	SRMR
Math	1462.53	542.00	0.056	0.053-0.060	0.915	0.907	0.049
English	1474.908	544.00	0.057	0.053-0.060	0.914	0.906	0.057
Kiswahili	1353.182	539.00	0.053	.050-0.057	0.925	0.917	0.046
Total	1702.168	606.00	0.048	0.045-0.053	0.916	0.907	0.048

English Performance

For English, the trend was the same. In the first model, with COP and EF skills, inhibition ($\beta = -.61$, $p < .001$) and working memory ($\beta = -.09$, $p < .001$) were negative predictors, while COP ($\beta = .60$, $p < .001$) was a positive predictor. In the MP model, working memory ($\beta = -.08$, $p < .001$), inhibition ($\beta = -.41$, $p < .001$), and MP ($\beta = .79$, $p < .001$) were significant predictors (Figure 19). When COP and MP were introduced into the same model, MP was a significant predictor of English performance ($\beta = .83$, $p < .001$; Fig. 2), while COP was not. Furthermore, inhibitory difficulties ($\beta = -.40$, $p < .001$) and working memory difficulties ($\beta = -.08$, $p < .001$) were significant negative predictors.

Figure 19

Standardized coefficients for the English Model



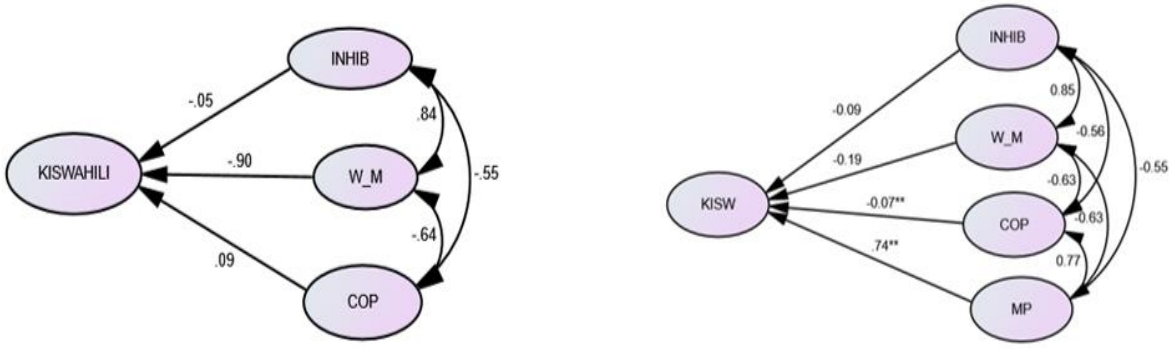
Note. Latent constructs are shown in circles. INHIB = Inhibitory difficulties; COP = Cognitive Object Persistent of Mastery Motivation scale W_M = Working Memory difficulties; MATH = Math performance in grade 1; MP = Mastery Pleasure

Kiswahili Performance

For Kiswahili, working memory ($\beta = -.90$, $p < .001$), inhibition ($\beta = -.05$, $p < .001$), and COP ($\beta = .09$, $p < .001$) were significant predictors in the COP model. In the MP model, inhibition ($\beta = -.33$, $p < .001$), working memory ($\beta = -08$, $p < .001$), and MP ($\beta = .85$, $p < .001$) were also significant predictors. When COP and MP were combined into one model, MP ($\beta = -.74$, $p < .001$) was a positive predictor for Kiswahili, but COP ($\beta = .07$, $p < .001$) was a weak predictor, and EF skills were insignificant (Figure 20). The total model, combining COP and MP, accounted for the most significant variance: 12% of the variance in mathematics, 25% in English, and 21% in Kiswahili (Table 27).

Figure 20

Simplified Standardized Coefficients for the Kiswahili Model



Note. Latent constructs are shown in circles. INHIB = Inhibitory difficulties; COP = Cognitive Object Persistent of Mastery Motivation scale W_M = Working Memory difficulties; MATH = Math performance in grade 1; MP = Mastery Pleasure

Table 28

Variance Explained by the Models (R^2)

	Cognitive Persistence			Mastery Pleasure			Cognitive persistence and mastery pleasure		
Model	Math	Eng	Kis	Math	Eng	Kis	Math	Eng	Kis
Math	.10	-	-	.15	-	-	.13	-	-
English	-	.20	-	-	.26	-	-	.26	-
Kiswahili	-	-	.13	-	-	.21	-	-	.21
Total	.10	.22	.18	.02	.04	.01	.12	.25	21

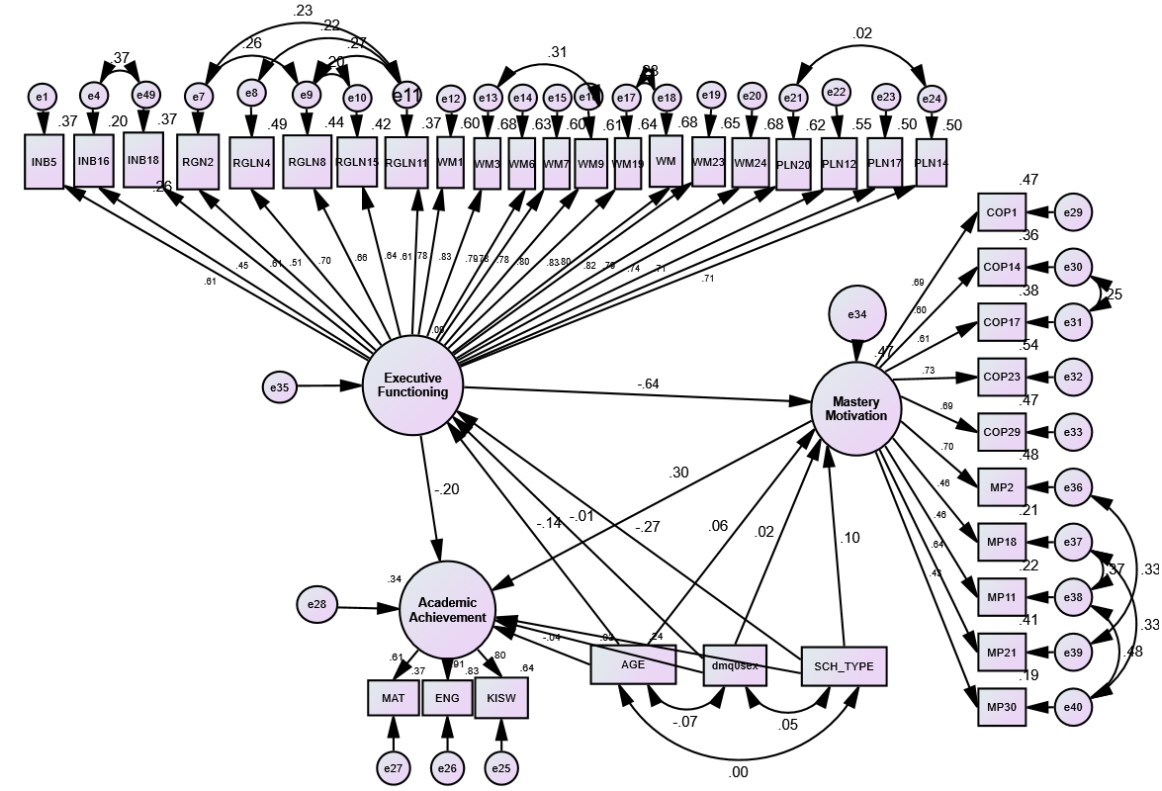
Note: Eng – English, Kis - Kiswahili

Taken together, both COP and MP positively predict academic performance in models 1 and 2 separately. However, when COP and MP were placed into one model, MP became more dominant, and the effects of COP were diminished: that is, MP became a more robust indicator, and COP became a weaker indicator. Regarding EF difficulties, inhibition and working memory were significant but negative predictors of academic performance in both models. Hypothesis III tested the presence of a direct effect of mastery motivation on Executive Function skills. COP, with 6 items, and MP, with five items, were strongly correlated, as shown in Figures 18 and 19, and thus were merged to represent the mastery motivation scale. Similarly, inhibition and working memory were also strongly correlated and were merged to represent the Executive Function difficulties scale (Figure 21). The results indicate that mastery motivation had

a significant but negative (inverse) direct effect on EF difficulties, such that the more significant the EF difficulties, the lower the MM and vice versa (Figure 6.5).

Figure 21

Direct and Indirect Effect of Mastery Motivation Executive Function Difficulties on Academic Performance



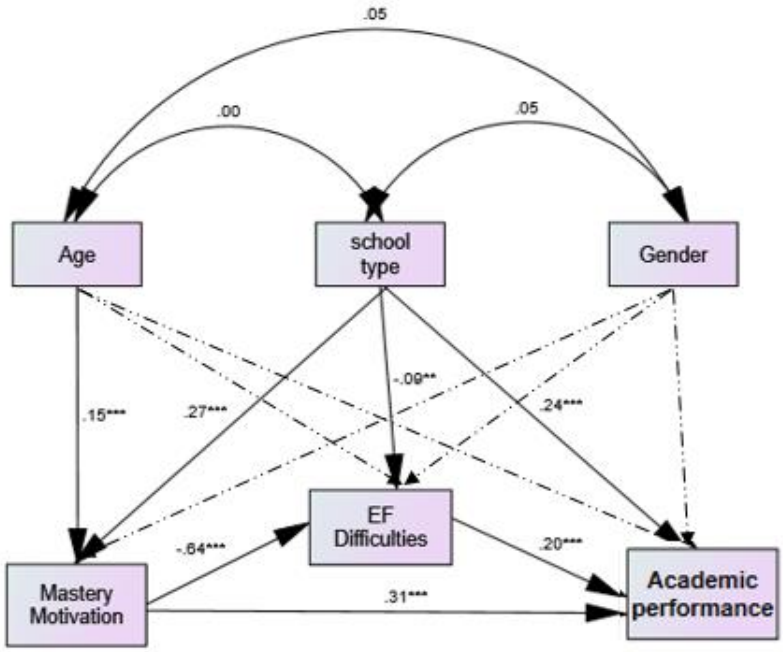
Note. Path model predicting academic performance in grade 1 from Mastery Motivation (cognitive persistence and mastery pleasure) controlling for age, type of school the child attended and child's gender. Coefficients presented are standardised linear regression. Solid continuous lines are significant while dashed lines are not significant.* $p < .05$; ** $p < .01$; *** $p < .001$. Fit indices $\chi 2$ =1614.906, Df = 601.00 CFI = .910, RMSEA = .056 (90% CI: .053, .060), SRMR = .04, TLI = .900

Figure 6.6 is an extract from Figure 6.5 displaying the direct and indirect effect of Mastery motivation and Executive functions on academic performance. Hypothesis IV tested MM → EF skills → academic performance path, i.e., investigating whether MM had an indirect effect on academic performance through EF skills (Figure 6.6). The results show that both the direct path coefficient (MM → academic performance) and the indirect path coefficient (MM → EF Skills → academic performance) were significant. On the direct path, if MM increases by 1 *SD*, academic performance

increases by 0.31 *SD*, and EF difficulties decrease by 0.64 SD. Conversely, if EF difficulties increase by 1 *SD*, academic performance decreases by 0.20 *SD*. Hence, EF skills partially mediate the relationship between mastery motivation and academic performance.

Figure 22

Mediation Model of the Relations between Mastery Motivation, Executive Functions skills and Academic Performance



Note. Simplified path model predicting academic performance in grade 1 from Mastery Motivation (cognitive persistence and mastery pleasure) controlling for age, type of school the child attended and child's gender. Coefficients presented are standardised linear regression. Solid continuous lines are significant while dashed lines are not significant.* $p < .05$; ** $p < .01$; *** $p < .001$. Fit indices $\chi 2$ =1614.906, Df = 601.00 CFI = .910, RMSEA = .056 (90% CI: .053, .060), SRMR = .04, TLI = .900

The indirect relationship between mastery motivation and academic performance as mediated via EF difficulties was significant (indirect effect: $\beta = .061$, $p < .001$), with a significant total effect ($\beta = -.297$, $p < .001$). For an effective increase in academic performance, EF difficulties should be reduced to a minimum. The mediating measurement model through EF skills indicated an acceptable fit: $\chi 2$ (708) = 1833.66, $p < 0.001$, $\chi 2/df = 3.223$, CFI = 0.904, SRMR = 0.054, and RMSEA = 0.055 (0.052, 0.058). This model accounted for 33.4% and 46.8% of the pupils' difficulties in

EF skills and academic performance variance, respectively. However, EF skills had no indirect effect on academic performance through mastery motivation.

Hypothesis V examined whether there was a significant difference between students with high mastery motivation and low Executive Function difficulties and those with low mastery motivation and high Executive Function difficulties. To identify which students may have required intervention according to the predictors, we placed the data onto a percentile scale and divided them into four groups: low in MM and high EF difficulty (worst needs intervention), low MM and low EF difficulty, high MM and high EF difficulty, and high MM and low EF difficulty. We used one-way ANOVA to determine whether there was a significant difference in academic performance in the four groups. Results showed a significant difference in MM and EF difficulty in mathematics [F (3, 237) = 17.598, p < .001], English [F (3, 237) = 33.526, p < .001], Kiswahili [F (3, 237) = 25.545, p < .001], and academic performance [F (3,237) = 40.054, p < .001] for the four groups. The post hoc comparisons showed that the mean score for low MM/high EF difficulty (M = 49.33, SD = 14.10) was significantly different from that for high MM/low EF difficulty (M = 74.74, SD = 16.09). Taken together, the pupils that had high MM/low EF difficulty (best) (n = 95) and those that had a low MM/high EF difficulty (worst) (n = 73) in academic performance showed a 25.41% p difference, in mathematics, 15.39% p; in English, 28.54% p; and in Kiswahili, 28.62% p. The eta effect sizes ranged from 0.18 to 0.34, signifying moderate to large eta effect sizes (Table 28).

Table 29

Means, Standard Deviations and One Way ANOVA of Academic Performance and Mastery Motivation and Executive Function Difficulties

Measure	Mastery Motivation and Executive Functions difficulties								F ratio (2, 237)	η^2
	LowMM, HighEFdiff		HighMM, HighEFdiff		LowMM, lowEFdiff		HighMM, lowEFdiff			
	M	SD	M	SD	M	SD	M	SD		
Math	61.63_a	20.08	64.32_a	15.21	70.29_b	15.73	79.79_c	14.69	17.60***	.18
Eng	43.45_a	17.21	49.84_a	19.97	59.42_b	24.30	72.99_c	19.60	33.53***	.30
Kisw	42.92_a	17.70	52.96_b	24.35	57.25_b	23.60	71.54_c	21.49	25.55***	.24
Average	49.33_a	14.10	55.71_b	15.02	62.32_b	15.91	74.74_c	16.09	40.05***	.34

Note. Means with different subscripts differ at p =.05; MM = Mastery Motivation ; EFdiff = Total executive function difficulties; Eng =English; Kisw = Kiswahili

***p < .001

Exploring the Differing Effect of Preschoolers' Executive Functions and Mastery Motivation has on Academic Performance Between School Types Attended

To answer Hypothesis VI, we used multilevel analysis in IBM SPSS to explore the likelihood that executive functions and mastery motivation affect academic performance due to the clustering of children in either private or public schools. We first explored the unconditional model before proceeding with analyses. We obtained a significant residual variance of 350.54 and an intercept of 60.55 ($p < 0.001$). This indicates that the unconditional model met the minimum requirements for multilevel analysis (Heck, 2013). The multilevel analysis showed a significant main effect of total executive functions (F (535) = 35.34, $p < 0.001$, mastery pleasure F (535) = 41.90, $p < 0.001$, cognitive persistence F (535) = 40.20, $p < 0.00$ and school type F (535) = 64.57, $p < 0.001$. However, there was no significant effect for gender (F (535) = 64.57, $p = 0.655$ and age of the child F (535) = 0.17, $p = 0.680$. There was a positive and significant effect of mastery pleasure on the academic performance of children clustered in schools.

Nevertheless, total Executive Function difficulties had a negative effect on academic performance, which was in agreement with the path analysis. In addition, students in public schools performed poorer than students in private schools (Table 29). Therefore, there is evidence that the negative relationship between the proportion of students from public schools and academic performance varies between schools.

Table 30

Multi-Level Summary Results for Academic Performance of Grade 1 Children Nested in Schools

	b	*SE b*	*LBC*	*UBC*
intercept	41.24**	6.14	29.18	53.30
Gender (1 –boys)	-0.60	1.3	-3.26	2.05
Age in years	-0.24	.59	-1.41	.92
Type of school the child attended(1-public)	-11.33**	1.41	-14.10	-8.56
Total Executive Function	-0.32**	.05	-0.43	-.22
Cognitive persistence	8.69**	1.37	6.00	11.39
Mastery pleasure	7.47**	1.15	5.20	9.73

SE, standard error; LBC, lower bound 95% confidence interval; UBC, upper bound 95% confidence interval
* $p < 0.05$
** $p < 0.01$

6.6.5 Discussion

The present study aimed to determine both direct and indirect contributions of mastery motivation and executive functions on the academic performance of grade one children in Kenya. The 2010 Constitution of Kenya holds that education is mandatory for all children (Republic of Kenya, 2010). This opens the avenue for all Kenyan children to have primary education, especially at-risk children, who might otherwise be limited due to low SES, demographic risk occasioned by poor maternal education, and other academic risks (Zuilkowski et al., 2018). It has been reported that children from low SES face greater academic difficulties than their peers (e.g., Fitzpatrick et al., 2014; Mousavi et al., 2022). This leads to a situation where children with an initial disadvantage continue to perform poorly while those with an initial advantage perform better, thus widening the gap between them (e.g., Pfost et al., 2014). As a result of free and compulsory education, the school enrolment rate has significantly improved, especially in primary schools, from 77.1% in 2017 to 109.4% in 2018 (Republic of Kenya, 2019). Despite the government's initiatives, children in private schools in Kenya have continued to outperform their peers in public schools in numeracy and literacy in the same geographical regions (Piper et al., 2016). This study also indicates that pupils from private schools exhibit better academic performance, mastery motivation, and executive functions, even after age, gender, and type of school were controlled. Several reasons could account for this, including better structural and process qualities in private schools than in public schools (Amukune, 2021; Amukune & Józsa, 2021).

One of the child development factors needing to be considered during this plastic stage of growth and development is the evaluation of mastery motivation (Pritchard-Wiart et al., 2019; Shonkoff & Philips, 2000). Econometric evidence has also shown that the return on investment is higher for intervention in early childhood than at the adolescent stage, and disadvantaged children stand to benefit the most (Heckman & Mosso, 2014). Furthermore, mastery motivation contributes significantly to resilience and school readiness domains, especially for at-risk children (Ramakrishnan & Masten, 2020). We tested whether mastery motivation could predict the academic performance of grade 1 learners. The cognitive persistence and mastery pleasure scales of mastery motivation generally contributed significantly to mathematics, English, and Kiswahili performance, while EF skill difficulties negatively predicted academic performance. Children with high mastery motivation and low executive function skills had a 28% p higher than those with low mastery motivation and high Executive

Function difficulties. This suggests that intervention strategies to help improve mastery motivation and executive functions can help close the gap between best and worst performance in academic performance.

Other studies involving low-risk children (e.g., Gilmore et al., 2003; Martin et al., 2013; Mokrova et al., 2013; Mercader et al., 2017) found a significant association between mastery motivation and academic performance. Ramakrishnan and Masten (2020) reported that mastery motivation was associated with mathematics skills among children experiencing homelessness, although the correlation vanished when age and intelligence were controlled for. Another study by Józsa and Molnár (2013) used multiple regression to compare three predictors of academic performance (cognitive persistence, Raven IQ scores, and a basic skills test) and discovered that cognitive persistence was the strongest predictor. Finally, Józsa and Barrett (2018) explored the relationship between the affective aspects of mastery motivation and mathematics and reading scores using structural equation modelling at grade 2. They found that negative reactions to failure negatively predicted mathematics scores but not mastery pleasure. Like this study, cognitive persistence was a good predictor of academic performance, but its predictive abilities disappeared when mastery pleasure was introduced, and mastery pleasure became the strongest predictor. However, few studies have examined the effects of mastery motivation on Executive Function difficulties. One possible reason for this could be that most of the studies on EFs have utilized performance-based measures that directly measure the underlying cognitive skills instead of behavioural measures that focus on applying those skills at home or school (Camerota et al., 2018; Toplak et al., 2013). In this study, pupils with high mastery motivation and lower Executive difficulties had higher academic performance, suggesting that mastery motivation and Executive Function skills are critical for school success. This result is not surprising because, theoretically, mastery motivation influences Executive Function skills (Pessoa, 2009).

Nevertheless, some studies have found no association between mastery motivation and executive functions Skills (e.g., Ramakrishnan & Masten, 2020) in at-risk children. Instead, higher EF abilities influence children's affective attitudes, which affect the motivation to learn, leading to better academic performance (Rash et al., 2016). Indeed, several studies have found that children with poor EF skills have a higher chance of having behaviour problems like physical aggression, impulsivity, lack of

concentration, and challenges in controlling their emotions in the classroom (Brophy et al., 2002; Jahromi & Stifter, 2008).

We compared the association of mathematics, English, and Kiswahili with EF difficulties and found that mathematics had a lower negative association with EF difficulties, indicating that it is more strongly associated with EF skills than English or Kiswahili. Similar associations were also reported by Thorell and Nyberg (2008) and Thorell et al. (2013). In this study, higher working memory difficulties predicted worse performance in mathematics and English, which is similar to the findings of Simanowski and Krajewski (2019), Waters et al. (2021), and Yang et al. (2019) for 6- to 7-year-old children. However, there were no significant differences in Kiswahili, a local language not officially used in instruction. This suggests that Kiswahili as a medium of instruction could be better than English in this sample, as it did not impose cognitive demands on the learners. Recently, authors have pointed out that the effects of EFs on children's academic performance have been mediated by approaches to learning and adaptive classroom behaviours (Nesbitt et al., 2015; Sasser et al., 2017). However, no indirect effects of executive functions on academic performance through MM were identified in this study. Several studies have indicated that self-regulation is a protective factor for children from impoverished backgrounds (e.g., Obradović, 2010). Hence, interventions that enhance EFs and MM should significantly improve approaches that support the learning of children from poor socioeconomic backgrounds.

Limitations of the Study

Our study had two limitations. First, we adopted a behavioural rating of MM and EFs. However, such measures may combine two or more constructs, such as behavioural regulation and engagement (Li-Grining et al., 2010; Sasser et al., 2015). Moreover, sometimes, teachers confuse motivation with class performance, thinking that students who do well are highly motivated, which is not always the case (Morgan et al., 2017). Second, parents could also provide more information on their children to reduce our reliance on one source of information.

6.6.6 Conclusion

MM has direct and indirect effects through EFs on pupils' academic performance in grade 1. Furthermore, MM and EFs play a pivotal role in learning and improving children's academic performance in elementary school. Therefore, strategies

that help improve MM and EFs can increase learners' learning and academic performance beyond focusing on curriculum alone or grades. Furthermore, Kiswahili should also be integrated into the classroom as an official language of instruction in grade 1, as its use would have a minimum cognitive load during instruction. Taken together, intervention strategies for MM and EFs can have immense benefits in bridging the gap between children attending private and public schools in Kenya. However, because both MM and EFs are malleable, selective intervention strategies that focus on the home and school can be adopted, especially among children with low MM and high EF difficulties.

6.7 Study 6: Comparison of Predictive ability of FOCUS App and Ratings of Mastery Motivation and Executive Functions in the Assessment of Approaches to Learning

6.7.0 Introduction

Understanding mastery motivation and executive functions' contribution to approaches to children's learning is vital for practice and policy. Although previous research has demonstrated the role of executive functions in behaviour and performance, the role of different contexts requires further study (Vitello et al., 2017). This study expanded the existing ratings of mastery motivation and introduced the FOCUS app, a game-like assessment of Pre-academic skills and mastery motivation as a direct assessment.

6.7.1 Objectives

The main objective of this study is to compare the predictive ability of the FOCUS app and behavioural ratings of Mastery motivation. First, we tested the FOCUS app – number and letter recognition tasks' ability to measure pre-academic skills across different school types and ages. Second, we tested whether mastery motivation assessed by ratings and direct assessments will predict academic performance in grade 1. Third, we examined the possibility of predicting school readiness based on FOCUS tasks – pre-academic tasks and mastery motivation. Finally, we further assessed executive functions using ratings.

6.7.2 Method

Participants

We collected data from 12 classrooms (5 private and 7 public) centres with 15 teachers. 10 to 20 children were randomly selected from each classroom, proportionately counterbalancing for gender. We recruited 154 grade 1 children (74 boys/80girls), with a mean age of 7.75 years (SD = 1.20). We used the type of school the child attended as an adversary status. We assumed that children who attended private schools were higher in SES than those who attended public schools.

6.7.3 Measures

Pre-academic Skills

To assess pre-academic skills, two tasks containing 15 items in number and letter recognition were administered to pre-school and grade 1. These tasks were administered using a game-like tablet-based assessment called Finding out Children's Unique Strength (FOCUS: Józsa et al., 2017). FOCUS app is designed to evaluate three competencies: pre-academic skills, mastery motivation and executive functions.

Mastery Motivation

Direct assessment of mastery motivation was also done using the FOCUS app. To assess mastery motivation, the game-like tasks 3-5 letter and number search tasks are designed to assess mastery motivation, operationalized as the child's persistence during moderately challenging tasks. The tablet provides a set of cards with corresponding numbers that the child is expected to match. The cards are either easy, moderately challenging or hard to match. The child's cognitive persistence is the time spent persisting on moderately challenging tasks. This approach to measuring mastery motivation is based on Morgan et al. (1992), who developed a procedure for separating a child's ability from motivation.

Teachers also completed the Dimension of Mastery Questionnaire 18 (DMQ 18; Morgan et al., 2020). A linear transformation was used to convert the mean to a range of 0 and 100 using a formula (x-1)* 25, resulting in percentage points (% p). Therefore, from 1 to 5 the percentage points changed as follows: 1 = 0%p, 2 = 25%p, 3 = 50%p, 4 = 75%p and 5 = 100%p (Józsa et al., 2019). The cognitive scale had excellent internal reliability of 0.821. The cognitive persistence scale of mastery motivation denotes the child's motivation to persist and master school-related and cognitive tasks (Józsa & Morgan, 2014). It also represents the strongest connection with school performance (Gilmore et al., 2003; Józsa & Molnár, 2013; Mokrova et al., 2013).

Task Persistence

This observation sheet required the examiner to observe the persistence of the child while undertaking the FOCUS tasks. Persistence was rated as the time the child was focused on trying to do the task. 1 = 0-19%, 2 = 20-39%, 3 = 40-59%, 4 = 60-79%, 5 = 80-100% (Józsa et al., 2017, p. 114). We recorded an approximate time when the child ignored the moderately challenging tasks and then calculated the approximate percentage of time spent persisting on moderately challenging tasks.

Executive Functions Skills

Apart from the ratings, a direct assessment of executive functions was done using a tablet-based assessment. The children were given two tasks. Tasks 6 and 7 are Size-Shape-Color Game, a modified version of the Dimensional Change Card Sort task (*DCCS*: Zelazo, 2006) designed to measure cognitive flexibility and inhibitory control but can also provide measures of mastery motivation. To assess executive functions skills, teachers also filled the CHEXI. The Childhood Executive Functioning Inventory (CHEXI: Thorell & Nyberg, 2008) is a 24-item questionnaire that is freely available online. This tool is explained in the methodology section.

Academic Performance

A standardized test developed and validated by the Kenya National Examination Council in partnership with Global Partnership for Education and World Bank was used to assess the academic performance of grade 1 pupils during the second term. All the items were obtained from grade-one textbooks approved by the Kenya Institute of Curriculum Development. The exam tested three subject areas - Maths, English, and Kiswahili (or Swahili in English), one of the official national languages in Kenya, as described in the methodology section.

Analytic Strategy

We used MPlus version 7 and the Rasch model to determine pre-academic skills' structural validity and its ability to measure pre-academic skills across different ages and schools. Second, Hierarchical Linear Regression was selected as an analytic model that will assess the unique contribution of mastery motivation, executive functions and pre-academic skills to academic performance (average of Math, English and Kiswahili languages). Child age, sex and type of school the child attended were controlled in the

model. The predictors were added to the model stepwise while noting the change in the variance depicted by ΔR^2. After controlling for child age, sex and school type, the second step was to enter Inhibition difficulties, working memory difficulties and mastery motivation at the third step. Academic performance outcomes, Math, Kiswahili and English languages were treated as dependent variables and entered each time separately. To identify the best model, Moore et al. (2021) criteria were used; if $R^2 < 0.09$ the predictive level is low, R^2, $0.09 \leq R^2 < 0.49$, moderate and $R^2 \geq 0.49$, high. Using G*Power 3.1.9.4, a sample size of 92 participants was big enough to yield a medium effect size at a power of 80%.

Procedure

Schools were stratified into public and private to ensure all schools were represented in the sample. Teachers first rated the pupils for mastery motivation and executive functions. This was followed by a direct assessment of pre-academic skills, mastery motivation and Executive functions using the FOCUS app. Children were first introduced to the computer tablet and the app during a warm-up session. Children were later requested if they wanted to play the game using the computer tablet. After their consent, the children were directed to a comfortable and silent room for the experiment. The FOCUS session began with the researcher filling in the login screen with a user identification and password. After filling in the child's age and gender, the researcher gave each child an anonymous ID number. To identify whether the child would take the tasks in English or Swahili, we asked the class teacher to indicate the language they commonly use during instruction. After setting these details, the child could proceed with the experiment.

6.7.4 Results

Descriptive statistics

Descriptive statistics indicating the means, standard deviations and range of each scale are shown in Table 30. The age of the grade one children ranged from 6 to 13 years. Both pre-academic skills and academic performance were slightly above the 50% mark.

Table 31

Descriptive results of pre-academic skills, executive functions, Mastery Motivation and academic performance

Variables	*M*	*SD*	Range
Pre-academic skills score			
Number Recognition	8.48	3.40	0-15
Alphabet Recognition	9.84	5.31	0-15
Total Pre-academic	18.32	7.62	0-30
Academic Performance score			
Math	67.12	17.28	0-100
English language	55.01	22.87	0-100
Kiswahili Language	54.96	23.29	0-100
Average Academic performance	59.03	18.32	0-100
mastery motivation			
cognitive persistence(DMQ 18)	3.64	.85	1-5
Mastery Pleasure(DMQ 18)	4.16	.56	1-5
Persistence on tasks	3.63	.65	1-5
IMCC	.03	.73	-2.00-2.00
Executive function difficulties			
working memory	39.73	10.25	1-5
inhibition	33.42	6.24	1-5
Total Executive Functions	73.16	15.74	1-5
Covariates			
Age	7.75	1.20	6-13
Child sex 1- female		51.9%	1
School type attended 1-public		56.5%	1

(i) Reliability and Validity of the Revised Letter and Number Recognition Tasks

The number and alphabet recognition reliabilities were high: Cronbach alphas were 0.84 and 0.94, respectively, and total reliability of 0.95. We also used CFA to determine the structural validity of the pre-academic skills in MPlus. CFA is one of the best methodologies to determine the structural validity of an instrument. We constructed two latent factors for number and letter recognition in MPlus version 7. The following cut-off criterion values were used to assess model fit: RMSEA < .06, CFI > .90 and SRMR

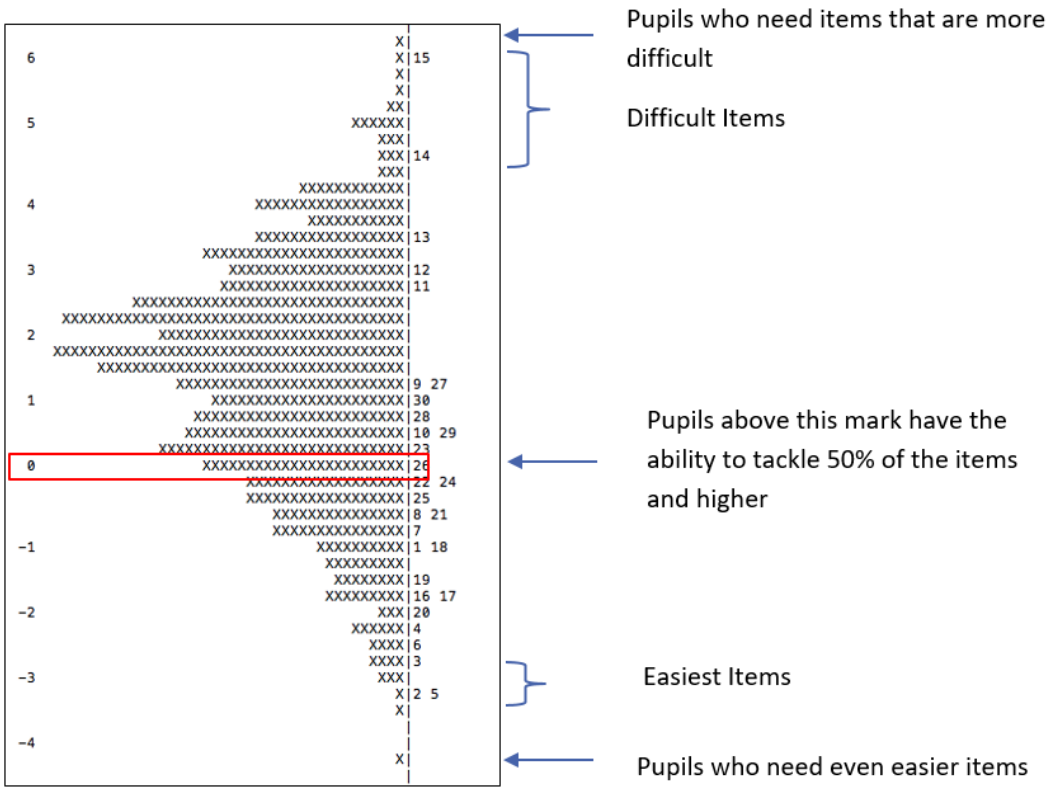
< .08 (Hu & Bentler, 1990). The model fitted well with the data: CFI = .984, RMSEA = .038 CI (.029 - .046), TLI = .983 and SRMR = .046.

(ii) The ability of number and letter recognition tasks from the FOCUS app to measure pre-academic skills across different schools and ages of children in the Kenyan context

We also used the item response model to examine whether the number and letter recognition tasks are suitable for assessing pre-academic skills across elementary grades from children of different ages in public and private schools. The results of the Rasch Analysis for pre-academic skills on the item level indicated a good fit model with the fit for single items (weighted mean squares, MNSQ) ranging from 0.63 to 1.86 (M = 1.45, SD = 1.90). The quality of the items in the pre-academic skills test was good since all the 30 items had discrimination values above the threshold of 0.3 (Ebel & Friebie, 1991). The items that correspond with the individual students indicate a 50% (p = .05) chance of answering them correctly. Items at the top of the ruler above 0 logits (SD = 1) are the most difficult, while those entirely below were the easiest (Figure 23). Item 14 and 15 in number recognition were the most difficult items, with a discrimination index of 0.63. Both the easiest and hardest items were in numeracy skills. Since most of the items spread along the ruler, this indicates that the items were good (Griffin, 2010) and could assess pre-academic skills across the different types of schools and ages. Therefore, the test fit well with this group. However, the alphabet was recognized more largely than numbers. The test seems to be a good measure of pre-academic skills across the elementary grades and targets well the test-takers.

Figure 23

Item map for pre-academic skills performance in grade 2



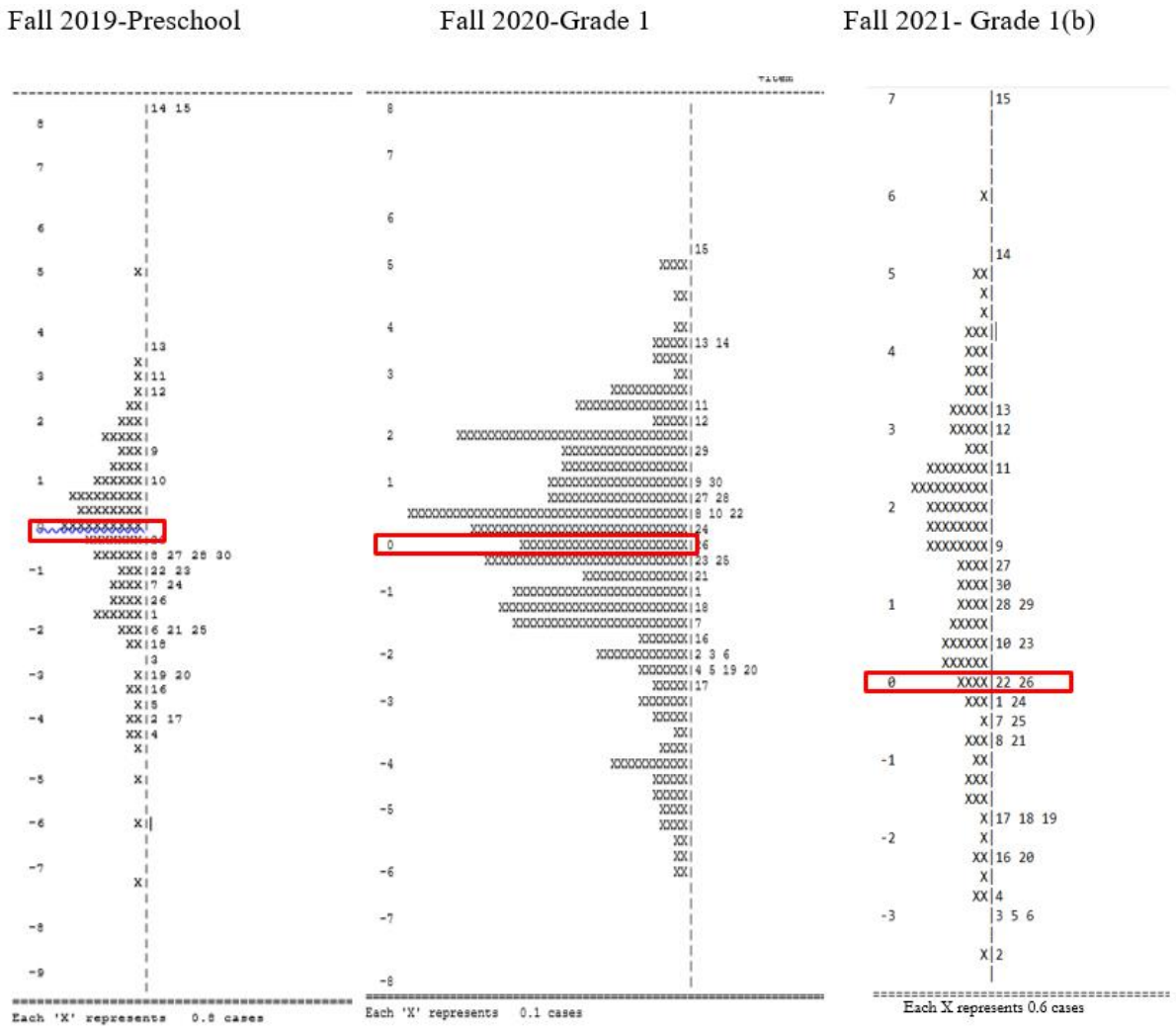
Note: Each x – represents 0.6 cases

(iii) Longitudinal growth of Pre-academic skills from preschool to school

We tracked the same students from preschool to grade two to monitor their growth of pre-academic skills over time. We used the Item Response model to examine the change in weighted MNSQ and whether the students improved over time. The results of the Rasch analysis for letter recognition in preschool (*M* = 1.52, *SD* = 2.89) and number recognition (*M* = - 0.59, *SD* = 2.55). According to Sahin, 2017 with a test of 30 items, a sample size of 30 participants is sufficient. At grade 1, letter (*M* = 0.27, *SD* = 2.59) and number (*M* = -0.722, *M* = 3.19). The children performed poorly from preschool to grade 1, and the MSNQ declined significantly. One year later the learners' performance improved tremendously, letter (*M* = 2.44, *SD* = 2.67) and number *M* = 0.96, *SD* = 1.88). However, the items were well distributed along the ruler, indicating that the items measured all the levels of learners' abilities (Figure 24).

Figure 24

Item maps of Longitudinal Change of Pre-academic Skills from Preschool to School



Bivariate Correlations of the Study Variables

Table 31 displays the bivariate correlations of the study. There were significant correlations between mastery motivation assessed by tablet-based (IMCC) and the cognitive persistence scale (COP DMQ 18), r = .22, p < .01. In addition, there was a stronger correlation between academic performance and cognitive persistence assessed by the FOCUS app than DMQ 18, r = .50, p<.01 and r = .37, p <.01. However, total executive functions difficulties was negatively correlated with both pre-academic skills and academic performance r = -.36, p <.01 and r = .54, p <.01. Further, pre-academic skills were strongly associated with academic performance in grade 1, r = .54, p <.01, indicating that children who did well in pre-academic skills can do better in grade 1. Additionally, there was a strong correlation between number and letter

recognition r = .51, p <.01. We also assessed the persistence of the child while undertaking FOCUS tasks based on the time they remained concentrating on the tasks. This persistence although small, correlated significantly with the Cognitive persistence assessed with the DMQ and FOCUS tasks r = .19, p <.01 and r = .23, p <.001 and with academic performance r = .43, p < .01(Table 31). We also used a *t*-test to compare the performance of boys and girls on mastery motivation, Executive Function skills, pre-academic skills and academic performance. Results indicated no significant difference, t (152) = -.265 – 1.597, p =.114 - .792 between boys and girls. However, there were significant differences in all the predictors based on the type of school the child attended, either private or public, t (152) = -3.795 – 6.155, p < .001.

Table 32

Zero-Order Correlation of the Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Age																
Sex	-0.030															
SchTy	0.000	-0.100														
NR	0.154	-0.059	0.158													
AR	0.151	0.069	.321**	.508**												
Pre.Acad	.174*	0.021	.294**	.800**	.923**											
Math	.218**	-0.036	.357**	.223**	.314**	.318**										
Kiswahili	0.118	0.019	.250**	.380**	.468**	.495**	.444**									
English	0.154	0.101	.333**	.443**	.522**	.561**	.531**	.826**								
Av.Acad	.182*	0.039	.357**	.415**	.514**	.543**	.724**	.907**	.933**							
AVPP	.213**	0.020	0.144	0.129	.230**	.218**	.423**	.336**	.389**	.437**						
IMCC	0.044	0.058	.279**	.199*	.382**	.354**	.418**	.445**	.429**	.498**	.230**					
COP DMQ 18	.232**	0.071	.287**	.236**	.267**	.291**	.211**	.326**	.397**	.370**	.194*	.215**				
MP	.168*	-0.014	0.124	.191*	.192*	.219**	.340**	.211**	.312**	.326**	0.056	.176*	.373**			
WM	-.227**	-0.081	-.442**	-.314**	-.354**	-.386**	-.337**	-.503**	-.557**	-.551**	-.264**	-.328**	-.504**	-.322**		
INHIB	-0.153	-.190*	-.402**	-.208**	-.250**	-.267**	-.311**	-.402**	-.487**	-.471**	-.181*	-.314**	-.522**	-.277**	.815**	
TOTALEF	-.208**	-0.128	-.447**	-.286**	-.329**	-.357**	-.342**	-.486**	-.555**	-.544**	-.243**	-.338**	-.535**	-.319**	.973**	.927**

Note. SchTy – School type child attended; NR- Number recognition; AR – Alphabet Recognition; Pre-Acad- Pre academic Skills, i.e. total of number and letter recognition; Av. Acad - the average of Math, English and Kiswahili; AvPP - the persistence of the child during moderately challenging tasks in number and letter matching; COP – Cognitive Persistence assessed with DMQ 18; IMCC(individualised moderately challenging Computer Score) – cognitive persistence assessed with FOCUS during moderately challenging tasks.

*$p < .05$ **$p < .01$

Comparison of Predictive ability of FOCUS App and Preschool DMQ 18

To identify between the FOCUS app and DMQ ratings, which is a better predictor of academic performance, we carried out a series of Hierarchical Linear Regression. Step 2 shows that cognitive persistence assessed by both Preschool Dimensions of Motivation Questionnaire 18 and FOCUS Tasks significantly predicted academic performance ($\beta = .20$, $p < 0.001$) and ($\beta = 0.40$, $p < 0.001$), respectively, although IMCC was a better predictor than Preschool Dimensions of Motivation Questionnaire 18. Moreover, the inclusion of mastery motivation assessed by the FOCUS app into the model contributed an additional ΔR^2 of 0.19 or 19%. Additionally, Mastery pleasure positively predicted academic performance ($\beta = 0.16$, $p < 0.001$). In step 4, working memory difficulties significantly predicted academic performance negatively ($\beta = .33$, $p < 0.001$), suggesting that children were likely to have low performance in academic performance when working memory difficulties were high. We also treated pre-academic skills as an independent variable to examine if they can significantly predict academic performance in grade 1. The results showed that pre-academic skills (number and letter recognition) assessed using the FOCUS app significantly predicted academic performance positively in grade 1 ($\beta = 0.30$, $p < 0.001$) even after accounting for sex, school type and age of the child. Pre-academic skills uniquely contributed 6% of the variance. This shows that if mastery motivation increases by 0.30, academic performance increases by 1 SD. When all the predictors were fitted in the model at stage 5, only mastery motivation assessed by FOCUS App, working memory and pre-academic skills were significant. The predictor variables accounted for 51% of the variance, which is a high predictive level (Moore et al., 2021). Thus, the FOCUS app was a better predictor of academic performance in grade 1 than Preschool DMQ 18.

Table 33

Hierarchical Linear Regressions Results Predicting Children's Academic Performance from Cognitive Persistence, Executive Functions Difficulties, and Pre-academic skills.

	Predictor variable	B	95%CI for B		SE B	β	R^2	ΔR^2
			LL	UL				
	Constant	13.33	-.8.21	34.86	10.90			
1	Age	2.83	.57	5.09	1.14	.185*	.17	.17***
	Gender	2.95	-2.46	8.30	2.74	.081		
	School type	13.45	.28	-2.46	2.76	.365***		
2	Constant	16.62***	-3.11	36.35	9.99			
	Age	1.83***	-.23	3.88	1.04	.12	.36	.19***
	Gender	.90***	-3.92	5.71	2.44	.03***		
	School type	7.06***	1.86	12.25	2.63	.19***		
	COP-DMQ18	4.29***	1.25	7.32	1.54	.20***		
	IMCC	9.60***	6.27	12.93	1.68	.40***		
3	Constant	-.02	-24.04	24.00	12.15			
	Age	1.61	-.42	3.64	1.03	.11	.39	.03**
	Gender	1.15	-3.60	5.89	2.40	.03		
	School type	7.09***	1.97	12.21	2.59	.19***		
	COP-DMQ 18	3.11*	-.04	6.26	1.60	.15*		
	IMCC	9.19***	5.89	12.49	1.67	.38***		
	MP-DMQ18	5.34**	.82	9.86	2.29	.16**		
4	Constant	47.60**	11.65	83.56	18.19			
	Age	.96	-1.01	2.93	1.00	.06	.45	.06***
	Gender	.16	-4.52	4.84	2.37	.00		
	School type	3.45	-1.78	8.69	2.65	.09		
	COP-DMQ 18	1.07	-2.19	4.33	1.65	.05		
	IMCC	8.07***	4.86	11.27	1.62	.33***		
	MP-DMQ18	4.03	-.35	8.40	2.21	.12		
	WM	-.60***	-1.01	-.19	.21	-.33***		
	INHIB	.03	-.63	.69	.33	.01		
5	Constant	44.84*	10.94	78.74	18.19			
	Age	.56	-1.31	2.43	1.00	0.04	.51	.06***
	Gender	-.21	-4.62	4.20	2.37	-0.01		
	School type	1.97	-3.00	6.95	2.65	0.05		
	COP-DMQ 18	.41	-2.68	3.49	1.65	0.02		
	IMCC	6.35***	3.23	9.47	1.62	0.26***		
	MP-DMQ18	3.43	-0.69	7.56	2.21	0.11		
	WM	-.41*	-0.81	-0.02	0.21	-0.23*		
	INHIB	-.18	-0.80	0.45	0.33	-0.06		
	PREAC	.71***	0.39	1.03	17.15	0.30***		
	TOTAL ΔR^2							.51***

Note. COP DMQ 18– Cognitive Persistence assessed with DMQ 18; IMCC(individualized moderately challenging Computer Score) – cognitive persistence assessed with FOCUS during moderately challenging tasks; MP-DMQ 18 – Mastery Pleasure assessed with the DMQ18; WM – working memory; INHIB- inhibition

*$p < .05$ **$p < .01$

6.7.5 Discussion

A growing literature has indicated that mastery motivation cognitive scale is a good predictor of academic performance out of risk (e.g., Gilmore et al., 2003; Martin et al., 2013; Mokrova et al., 2013; Mercader et al., 2017) and at-risk children (e.g.,Ramakrishnan & Masten, 2020). We, therefore, compared ratings of cognitive persistence and mastery pleasure on the Preschool Dimensions of Motivation Questionnaire 18 and the direct assessment of cognitive persistence using the FOCUS app. Different methods have been used to assess Approaches to Learning, such as teachers' reports, parent reports and direct assessments (Li et al.,2019). However, the critical mastery motivation construct has continuously been assessed using parent and teacher reports, given the paucity of easily administered, psychometrically robust assessments. Moreover, although psychometrically strong, direct assessments of mastery motivation and executive functions exist, they need to be administered individually by highly trained examiners and are thus time, cost, and labour intensive (Józsa et al., 2017). In a multimethod study, Li et al. (2019) compared the three Approaches to Learning measures: parent reports, teacher reports, and direct assessments. Results indicated that direct assessment was more relevant to children's early childhood development than parent and teacher reports. Therefore, the study recommended using direct assessment and parent/teacher reports as supplementary. A form of direct assessment that could be administered without intensive training of examiners is a narrated, self-administered, computer tablet-based method such as the FOCUS app. Direct assessment of cognitive persistence using the FOCUS App was a better and more significant positive predictor of academic performance even after taking care of age, gender and type of school the child, attended as covariates. This study adopted the school the child attended as an adversity measure of socio-economic status. These background variables, such as age, SES and gender, correlate with executive functions and should be treated as covariates (Jacob & Parkinson, 2015).

Furthermore, executive function skills assessed using the CHEXI had a significant but negative predictor of academic performance, suggesting that high mastery motivation and lower executive function difficulties result in higher academic performance (e.g., Nesbitt et al., 2015; Sasser et al., 2017). Other similar studies in the assessment of executive functions have shown that executive functions assessed using ratings and direct assessments have a low correlation. This is attributed to ratings assessing skills' application, while direct assessments assess the underlying cognitive

abilities (Camerota et al., 2018). Additionally, the child's persistence while tackling moderately challenging tasks was also a significant predictor of academic performance, although weaker than the cognitive persistence assessed by the FOCUS app. The present study also directly assessed pre-academic skills, which other studies have used to measure academic school readiness. The pre-academic skills of number and letter recognition positively predicted academic performance in grade one. Additionally, Rasch analysis also demonstrated that the number and letter recognition tasks are suitable for assessing pre-academic skills across gender, school types and different ages in elementary school. Pre-academic skills were the best predictor with standardized beta regression coefficients of .30 each, followed by mastery motivation assessed directly by FOCUS with .26 each. Unfortunately, the effect of mastery motivation assessed with Preschool Dimensions of Motivation Questionnaire 18 was not significant in model 5. Therefore, mastery motivation and pre-academic skills are potential predictors of academic performance during preschoolers' transition to grade 1.

Preschool to School Transition in Kenya.

The longitudinal study of pre-academic skills showed that student performance had reduced drastically from preschool to school assessment. Several factors have been blamed for inadequate preschool to school transition in Kenya. First, the change of friendly environment in preschool to strict formal schooling in grade one and lack of teaching resources (Njenga & Kabiru, 2001). The second is the professional qualification of the teacher. Wamaitha (2013) established a six-fold higher chance of dropping out in untrained teachers' classes than in classes taught by trained teachers. The third is the language used for instructional purposes. Language policy in Kenya dictates that instruction in early childhood education is the catchment language or language spoken by the local community (Gachathi Report, 1976; UNESCO, 1953). Most schools have promoted English and Swahili as the medium of communication and instruction in schools, disregarding local languages, culture, and childrearing practices (Okwany et al., 2011; Ng'asike, 2014; Wadende et al., 2016). The situation is similar even in neighbouring countries like Ethiopia, where speaking English and Amharic is one of the most extensive parental expectations of early childhood education (Dighe & Seiden, 2020). There are several reasons why it has been challenging to offer instruction using the indigenous languages: lack of teachers, lack of terminology, lack of books, the threat to national unity and parental preference (Mose, 2015) are some of the

reasons. This sudden change of language from preschool to school for children with poor English literacy skills creates a barrier to learning, transition and child to child interaction in the classroom (Uwezo, 2016). Fourthly is the introduction of free primary education in 2003. This caused students from poor backgrounds to skip preschools and go straight to grade one. This caused a reduction of learners in preschools (MOEST, 2003) and resulted in higher admission of students by 17% in grade one. This caused poor retention of those students in the schools and a challenging grade one environment (Wamaitha, 2013). High child-teacher ratios and a lack of teaching and learning materials contribute to higher dropouts and poor quality teaching in grade one (Arnold et al., 2007; Jemutai, 2018; Wamaitha, 2013). The fifth reason is the KICD/NACECE curriculum that was academic and failed to prepare learners in other areas of development, such as personal, social and emotional development, which are essential in school readiness, school transition and success in life (Berlinsky & Shady 2015; Kariuki et al., 2009). It is envisaged that the new competency-based curriculum will correct this anomaly since it is structured based on the child's holistic development and focuses on competencies, not mastery of content for examination purposes alone (Republic of Kenya 2017a).

Family-related challenges also affect the transition to school. For example, there are instances where parents are not aware of their role in stimulating children to participate in academic activities; instead, they relegate this to teachers (Ngugi, 2006; Wambiri, 2007). similar observations were noted in Ghana, where parents only focused on homework but not on what happens in the School (Kabay et al., 2017). If parents and teachers do not abide by their roles, the teacher-parent relationship will be in jeopardy (Powell & Diamond, 1995). Similarly, Koech (2014) reported a disconnect between parents, teachers and education officials concerning the mode of parent-teacher partnership in decision making, parenting and volunteering. The study recommended that parents, teachers and ministry officials' collaboration should be enhanced.

This work has two limitations. Firstly, teachers only rated the children. It would have been prudent to get the views of the parents who also have factual information regarding their children. Teachers sometimes confuse motivation with class performance, such that students with high academic performance are assumed to be highly motivated. Other reasons include children with and without developmental delays and gender and age differences (Morgan et al., 2017). Secondly, performance-

based measures could have helped collect actual data from the children for comparison with the ratings.

6.7.6 Conclusion

Precise assessment of school readiness and approaches to learning is explicitly critical for school and life success. The study demonstrated that mastery motivation and pre-academic skills assessed by the FOCUS app better predict academic performance. Therefore, preacademic and mastery motivation assessed by the FOCUS app can be a good predictor of academic performance in grade 1. Conversely, students posing low results from pre-academic and mastery motivation tasks can post poor academic performance results in grade 1. Therefore, interventions to improve mastery motivation and executive functions have a higher promise of improving academic performance.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

Although school readiness has been studied, there is a paucity of research on Approaches to Learning as a domain of school readiness in Kenya. Therefore, the main goal of this study was to enhance the assessment of school readiness and precisely capture Approaches to Learning, one of the poorly assessed domains. Extant studies have indicated that Approaches to Learning have the potential to predict both school and life success. However, most studies have focused on assessing academic performance that predicts school success alone. In practice, Approaches to Learning is assessed based on a short report that is mostly not filled, ignored, or missing in totality in many school readiness tools.

Furthermore, when direct assessments are used, they require trained examiners, who are always lacking in LMIC countries. In addition, teachers do not have time to administer questionnaires to assess Approaches to Learning, nor are they professionally trained to interpret the results. To address these challenges, we developed a self-administered game-like app that requires no training to assess school readiness, specifically Approaches to Learning and pre-academic skills. Therefore, we adapted and developed the app, tested it, and carried out empirical studies to explain the role of mastery motivation and executive functions on academic performance. The app has the potential to identify children with low mastery motivation and executive functions and help to strategise possible individualized interventions. The Dissertation derived the following Conclusions from the empirical studies.

7.1 Conclusions

The first study was based on a scoping literature review to establish what other researchers in the field of school readiness had done during school readiness assessments. Our first question, S1Q1, examined the 31 studies that addressed the assessment of school readiness domains and the most frequently assessed? There was only one study that featured Approaches to Learning. However, over 75% of the studies addressed academic performance. The RQ2S1 of the scoping review also revealed that, despite the evidence-centred design mostly recommended for Game-based assessment, most studies still adopted external assessments following pre-and post-assessments. This kind of assessment leads to a “black box” scenario that exists in the Game-based

assessment. The assessor cannot capture what happens in the game but rather the evaluation of the pre-and-post questionnaires. However, inside the black box, the examiner loses the opportunity to capture other pupils' abilities, such as problem solving and creativity. RQ4S1 evaluated what intervention procedures were initiated to enhance school readiness. The intervention strategies focused on the curriculum subjects, especially math, reading and sciences, in a quasi-experimental design. There was no focus on other schools readiness domains, such as Approaches to Learning and socio-emotional domains. From the outcome of this review, we identified only one study that addressed mastery motivation and executive functions. This confirms the assessment of academic performance as the most assessed domain. Since the research group that initially designed the app is from the University of Szeged, it was easier to obtain the source code, and therefore we agreed to further the development process rather than start from scratch.

Study 2 tested the Initial feasibility of the FOCUS app. RQ1/S2 showed that the FOCUS app is valid and reliable in the Kenyan context to assess the pre-academic skills and mastery motivation. Although pre-academic skills and mastery motivation posted successful results, there were challenges with the executive function tasks associated with the software. RQ2/S2 sought to establish whether there is a relationship between pre-academic skills assessed using the FOCUS app and academic performance in Grade 1. Results indicated that assessment of pre-academics skills and mastery motivation (RQ3/S2) were directly related to academic performance in grade 1, indicating that the use of the FOCUS App at preschool can help identify children with inadequate learning experiences. Beyond our expectations, children performed poorer in grade 1 than in preschool. Therefore, the RQ4/S2 that tested whether there was a significant difference between preschool and grade 1 was upheld. This indicates that children from preschool face transition challenges in grade 1.

Further studies are needed to explore this poor performance from preschool to school. RQ5/S2 tested whether pre-academic skills from the FOCUS app can predict academic performance in grade 1. As expected, the FOCUS app tasks successfully predicted grade 1 academic performance. This test was practical to allow the examiners to use the FOCUS app at preschool to judge the child's performance in the future.

We used preschool mastery motivation questionnaire 18 in English and Swahili and FOCUS App to assess mastery motivation for direct assessment. The Swahili version was used to collect data from participants who are not fluent in English,

specifically, parents of preschool children. Since the Swahili version is not available, we sought first to develop one that will be used to complement the FOCUS App during school readiness testing. A Swahili version will fill a considerable gap since Swahili is spoken by over 150 million in Africa. Kiswahili is also the only African language that has received UNESCO recognition. The test for psychometric properties (RQ1/S3) of the newly translated Swahili version met all the psychometric requirements and was found to be valid and reliable. Additionally, the ratings of parents and teachers on the DMQ scale were significantly different except for cognitive persistence and mastery pleasure (RQ2/S3), meaning parents and teachers see children differently but agree on their thinking abilities. However, RQ3/S3 indicated a significant difference in all DMQ subscales between children above the normative age for preschool II of 5 to 6 years and above six years, except for cognitive persistence. This indicates a cognitive risk of retaining older children among young ones in the same class. Therefore, children should be recruited and placed at the class level that best suits their age.

The other variable of interest for this study was executive functions. To assess executive functions, we used the Childhood Executive Functioning Inventory (CHEXI: Thorell et al., 2008) for behavioural rating and the FOCUS app for direct assessment. We first validated the CHEXI before investigating the association of executive functions with academic performance (RQ1/S4) in the Kenyan context. Like the Preschool Dimensions of Motivation Questionnaire 18, the CHEXI demonstrated strong psychometric properties and is suitable for assessing executive functions skills in Kenyan culture. Therefore, we added two critical tools for assessing mastery motivation and executive functions in the Kenyan context. We also tested whether gender will influence the examiner rating a child for executive functioning, also known as gender invariance. The outcome of RQ2/S4 confirmed that the results from the CHEXI assessment are free from gender biases. RQ3/S4 tested whether there were differences in Executive Function difficulties based on gender, age and school the child attended. Results showed no gender differences between boys and girls based on Executive Functioning.

Nevertheless, there were significant differences between different age groups and children from public and private schools. Young children were more likely to have more deficits in executive functions than older children in the same class. In general, children from private schools outperformed public schools in executive functions skills and academic performance (RQ4/S4). In addition, there was a close association between academic performance and Executive Function skills (RQ5/S4). Children who had high

Executive Function difficulties performed poorly in academic performance. Therefore, Executive Function difficulties were a significant predictor of academic performance (RQ6/S4).

After validating the Pre-school Dimensions of Motivation Questionnaire 18 and the CHEXI, we introduced the two constructs in one study to investigate the contribution of Mastery Motivation and executive functions to the Academic Performance of First Graders in the Kenyan context. The present study operationalized that mastery motivation and executive functions are essential components in Approaches to Learning. We tested six hypotheses regarding mastery motivation, executive functions and academic performance. First, grounded in theory, we tested whether mastery motivation and executive functions are directly or indirectly related to the academic performance of grade one children in Kenya. This study theorized that both mastery motivation and executive functions are essential components of approaches to learning. Second, HI/S5 tested whether mastery motivation has a significant and direct effect on academic performance. This hypothesis was confirmed.

Additionally, mastery pleasure had a more substantial effect on academic performance than cognitive persistence. In H2/S5, Executive Function deficits were also a significant predictor but negative, suggesting that academic performance reduces when Executive Function difficulties increase. However, Kiswahili as a subject was not significant, suggesting that Kiswahili does not intensively provide a cognitive load to the learner like math and English language. It is, therefore, easier cognitively to understand in Swahili. Most children in this sample speak Swahili both at home and at school. H3/S5 tested the relationship between mastery motivation and executive functions. Results indicated that mastery motivation contributes to the development of Executive Function skills, suggesting that low mastery motivation leads to more significant Executive Function difficulties. We also tested in H4/S5 whether there was an indirect effect between mastery motivation and academic performance through executive functions difficulties. This hypothesis was confirmed; however, the mediation was partial. Finally, we tried whether there will also be an indirect effect between executive functions and academic performance through mastery motivation, but this hypothesis was not confirmed. This hypothesis showed that if mastery motivation is enhanced, there are higher chances of improving Executive Function skills. Due to these significant effects between mastery motivation and executive functions, we grouped students according to whether they had low mastery motivation

and executive functions skills. Using these groups, we tested H5/S5 to determine whether there were significant differences between categories with low mastery motivation and great Executive Function difficulties and those with high mastery motivation and low Executive Function difficulties. H5 indicated that students with low mastery motivation and high Executive Function difficulties had a low academic performance. This result supports the idea that enhancing mastery motivation and executive functions can improve academic performance by 28% points. Theoretically, we conceptualized that mastery motivation and executive functions are components of approaches to learning. Therefore, high mastery motivation and low executive function deficits signify high levels of mastery motivation.

After the development, testing and validation of the FOCUS app, we collected a large sample to compare the assessment of mastery motivation using direct assessments in the FOCUS app and ratings using the Preschool Dimensions of Motivation Questionnaire 18. We first explored whether the FOCUS app can assess pre-academic skills across different age groups and gender. RQ1/S6 sought to determine if it still met the validity and reliability requirements after revising the first version of the FOCUS app for the Kenyan context. We, therefore, tested the validity with a large sample. The reliability and validity of the FOCUS app were above the minimum requirement. RQ2/S6 also confirmed that the FOCUS app could assess children of different ages and schools. This is extremely important for Kenya since students join the school at different ages and from different preschools. Therefore, the use of a tool that is unbiased is critical in identifying children for individualised intervention. RQ3/S6 examined and tracked the changes in number and letter knowledge from preschool to school using FOCUS app tasks. Beyond our expectations, the results indicated that the students performed even poorer just one month after transitioning to grade one. This poor academic performance in grade 1 indicated transition challenges from preschool to school in Kenya. Finally, RQ4/S6 compared between assessment of mastery motivation using ratings and the FOCUS app task. Previous studies have shown that mastery motivation is a significant predictor of academic performance. We, therefore, compared the Preschool Dimensions of Motivation Questionnaire 18 and FOCUS task results to determine which assessment method predicts the best academic performance at school. The FOCUS app was a much better predictor than the Preschool Dimensions of Motivation Questionnaire 18, suggesting that the FOCUS app is a better tool that can be applied in the Kenyan context. RQ5S2 confirmed that pre-academic skills assessed

using number and letter recognition also significantly predicted academic performance in grade 1.

7.2 Recommendations

Recommendations for Teachers

1. FOCUS App hold much promise in providing individualised information on pre-academic skills, mastery motivation and executive functions for further intervention. Therefore, we recommend using the FOCUS App to identify learners with mastery motivation and Executive Function challenges. Moreover, for full School Readiness assessment FOCUS app is an essential complement to the existing tools of that country, e.g., Kenya School Readiness Test in Kenya and DIFER in Hungary.
2. Assessment of mastery motivation and executive functions can diagnose a learner's Approaches to Learning. This outcome can be used to diversify the teaching and learning methods of the pupils.
3. The FOCUS app can help diagnose whether poor academic performance is due to low motivation or Executive Function difficulties and vice versa.
4. Although FOCUS App is a better predictor of academic performance than rating scales, we recommend using both ratings and direct assessments to give stakeholders diverse opinions about the child.
5. Children should be placed correctly based on age: preprimary one at four years, preprimary two at five years and grade 1 at six years, as recommended by the Ministry of Education in Kenya.
6. Specialised training in teacher training colleges or professional development can be offered to teachers to empower them on how to mitigate children with low mastery motivation and executive functions and address those challenges.
7. Emphasis should be placed on classroom management especially targeting Math skills through lessons and daily school activities that focus on Executive Function skills.
8. Since executive functions and mastery motivation differs based on age, there is also a great need to offer differentiating teaching targeting learners' individual needs of different ages.

9. Teacher-training programmes, school management, and parent associations need to provide specialised courses and programmes to empower teachers and parents with skills to handle children during preschool to school transition.

Recommendation for Research

1. FOCUS App is valid and reliable for cross-section and longitudinal studies
2. Preschool Dimensions of Motivation Questionnaire 18(Morgan et al., 2020) and the CHEXI(Thorell & Nyberg et al., 2008) was adapted and validated in the Kenyan context and found suitable for assessing mastery motivation and executive functions, respectively.

Recommendation for Policy

1. The FOCUS app can complement other school readiness tools, but an enabling policy needs to be implemented.
2. Kenya School Readiness Tool should also assess Approaches to Learning and Socioemotional domains at equal strength, like pre-academic skills.
3. Activities such as boundary teaching, where preschool and grade one teachers share information and curriculum content, can enhance safe landing during preschool to school transition
4. Apart from enhancing cognitive persistence, mastery pleasure is also essential in young children's learning. Therefore, a child-friendly curriculum rather than a very academic curriculum can support the motivation and growth of executive functions.
5. Prioritise Kiswahili as a language of instruction, especially in regions spoken at home and school.

7.3 Limitations, Further Research and Practical Implications

FOCUS App is a good tool for assessing pre-academic skills, mastery motivation and executive functions. However, a random error in the app hinders the processing of executive function tasks. This challenge requires revising the source code to remove the error and update data processing. In addition, the current version of the FOCUS app administers tasks based on age. Therefore, examiners must get the child's correct age to match the tasks. Further research is required to build the app to enable it to administer tasks based on the child's competence. In addition, other modules and languages could be added to the FOCUS menu to make it more adaptive to school readiness tests.

Second, there is a need to obtain a national representative sample that can be used to develop preliminary norms. Such norms help compare individual samples for immediate feedback to the parent or teacher. Such feedback can also be coupled with an appropriate intervention procedure and results presented to the user through an interactive dashboard. Recently, other tools have assessed other domains of school readiness apart from Approaches to Learning. For example, Early Years Toolbox can be combined with the FOCUS app to give stakeholders diverse options.

Additionally, other rating tools exist for assessing Approaches to Learning, such as Preschool Learning Behavior Scale, compared with preschool DMQ 18 and CHEXI combined results. Since FOCUS App also assesses Approaches to Learning, the three results can be compared if they are measuring the same constructs. Other studies have also indicated that pupils with low mastery motivation and executive functions had a higher probability of being affected by Mild Intellectual Disability. Further studies can be pursued to establish if the FOCUS app can also screen children with Mild Intellectual disabilities.

Additionally, the CHEXI Kiswahili version helps collect data from parents who are not competent in English. The CHEXI can further be used to collect longitudinal data and be compared with the FOCUS app. Other questionnaires are also available to identify executive function deficits, e.g., the BRIEF, which can also be compared with the CHEXI using the Kenyan sample. Despite the utility of Preschool Dimensions of Motivation Questionnaire 18 and CHEXI, there is a need to collect extensive sample data to establish the two tools' preliminary norms.

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Declaration

I hereby declare that the content of this dissertation is my work except where due acknowledgement has been made. This dissertation contains no material that has been submitted for any other academic degree program.

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

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APPENDICES

Appendix 1: Letter of Consent to Parents and Teachers

Study Title: *Mastery Motivation and Executive Functions as School Readiness Factors: Enhancement of School Readiness in Kenya.*

Dear Parent/Teacher,

I am a PhD student at the Institute of Educational Sciences, University of Szeged, Hungary. I intend to carry out the above study on approaches to learning. This study will involve preschool children, parents and teachers of Kilifi County. For all students sampled automatically, their parents/guardians become part of the participants who will provide further information regarding their children's learning.

The study aims to enhance school readiness by developing approaches to learning using Mastery Motivation and executive functions factors. These two factors will help parents and teachers predict the child's school readiness status and plan for intervention where necessary. First, teachers and Parents will be asked to fill in a Questionnaire on behalf of the child. Later the child will be provided with tablet-based game-like tasks to assess the Mastery Motivation and Executive Functions of the child. Participation in this study is voluntary, and participants can withdraw at any time.

All data collected in this study will be kept under lock, and key and server details will be kept under a secure password. Responses will be kept confidential, and the use of pseudonyms enforced. After the study, parents, teachers and other stakeholders are entitled to free access to the published reports.

There is NO anticipated risk at all to taking part in this research. The study hopes to introduce digital methods of assessing approaches to learning, one of the vital school readiness factors that are rarely fully assessed. This information will help teachers, clinicians, parents, policymakers, and researchers predict the child's future academic potential and provide individualised intervention in case of maladjustments. This will help enhance school readiness in Kenya and improve the Kenya School Readiness Assessment Test.

CONSENT:

I …….agree to participate in the study. I am the parent of …..……in school…….…….

Signature:…….. Date:……

Thank you very much for your support and consideration.

Stephen Amukune

Email: steamukune@gmail.com; Cell: +254726971112/+36 20408732

Appendix 2

Appendix 2: Kenya School Readiness Test

For Children Transiting to Grade One Instructions to the assessor

A General Information

1. Name of the child-

   ……..

2. Sex: Male [ ] Female [ ]
3. Date of Birth: (As per the birth certificate/clinic card/birth notification)

   Day ……..Month…….Year……..……..
4. Name of Parent/Guardian……
5. Contact of Parent/Guardian……..……
6. Postal Address……
7. Residence/Area/Street……
8. Telephone/Mobile number……Email address…….
9. Name of Learning Institution: ……
10. Type of school : Public [ ] Private [ ]
11. Location: Rural [ ] Urban [ ] Informal settlement [ ]
12. County: ……County: ……
13. Name of Teacher/Assessor:……
14. Date of Assessment: Day …….. Month……Year……

Child's Well Being

A. Is the child fully immunized against the following diseases?

	Yes	No
• Tuberculosis (BCG)	☐	☐
• Measles	☐	☐
• Polio	☐	☐
• $DPTH_{ib}$	☐	☐

B. Does the child suffer from any known chronic health condition?
Yes…….. No…… If YES, specify …….

C. Growth Monitoring and Promotion (GMP) indicators

- Weight (kilograms)……
- Height (metres)……

BMI (Body Mass Index, [kg/m^2])	<18.5(underweight)	18.5 - 24.9 (normal)	25> (overweight)

D. Does the child have any of the following special needs?

Speech impairment	
Hearing impairment	
Visual impairment	
Physical disabilities	
Behavioural disorders	
Emotional disorders	
Learning difficulties	
Mentally challenged	
Autism	
Others (specify)	

General Comments

i. Comment on the child's wellbeing……

ii. Comment on the child's readiness to transit to Standard One (Strengths to enhance and weaknesses to improve upon.....

Instructions to the teacher or assessor

a) This tool must be used in reference to the Assessors Guide.
b) All sections of this tool **MUST** be completed. Fill in or explain. A child with special needs should be assessed according to his/her abilities.
c) The child should be assessed in his/her natural setting.
d) When filling out this tool, the assessor should refer to progress records maintained continuously over the year.
e) This tool should not be used to rank or exclude any child from transiting to Standard One.
f) This tool aims to establish the level of competency of a learner in various learning activity areas.
g) Put a tick (√) on the preferred rating box.

A1: Language Learning Activities

This area includes oral, reading and writing readiness skills

strand	Competencies	Assessment scoring rubrics according to the level of expectation				Remarks
		Exceeding	Meeting	Approaching	Below	
Listening	Responds to a variety of listening experiences					
	Recalls letter sounds in class					

Speaking	Convey verbal messages effectively					
	Articulates vowels and consonants and demonstrates letter-sound correspondence					
Reading	Holding a book correctly, reading orientation, turning pages					
	Recognizes letters of the alphabet					
writing	Write simple line patterns					
	Write letters of the alphabet correctly					

A2: Mathematical Learning Activities

This Includes number concept and quantities, number relations and operations, geometry and
spatial sense, patterns measurements and comparisons

Strand	Competencies	Assessment scoring rubrics according to the level of expectation				
		Exceeding	Meeting	Approaching	Below	Remarks
Classification	Groups objects according to different attributes					
	Uses appropriate vocabulary related to ordering					
	Arranges similar objects to make a pattern					
Numbers	Rote counts numbers up to 10					
	Counts concrete objects 1-9					
	Writes number symbols 1-5					
Measurement	Measures different sides of objects					
	Compares heavy and light objects in the environment					
	Measures surfaces of objects					

A4: Environmental Activities

strand	Competencies	Assessment scoring rubrics according to the level of expectation				Remarks
		Exceeding	Meeting	Approaching	Below	
Picture making	Draws simple picture from observation or memory					
	Colours objects in more than three different colours					
Modelling	Model simple objects using ball, coil and slab techniques					
	Creates objects in 3 dimensions using locally available techniques					
Performance	Performs simple singing games					
	Produces rhythmic patterns using body parts					
Displays fun	Displays fun as they stretch and bend					
	Performs various manipulative activities					

A4: Religious Education Activities

Christian Religious Education Activities

strand	competencies	Assessment scoring rubrics according to the level of expectation				Remarks
		Exceeding	Meeting	Approaching	Below	
Creation	Identifies things provided by God					
	Says prayers at different times					
Christian festivals	Names different Christian festivals					
	Sing songs in praise of Christmas					
Greatest commandment	State the greatest commandment of God					
	Demonstrate the love of God					
Places of worship	Identify different places of worship					
	Identify activities during church worship					
Behaviour in church	Display good behaviour					
	Appreciate the importance of good behaviour in church					

Islamic Religious Education Activities

strand	competencies	Assessment scoring rubrics according to the level of expectation				Remarks
		Exceeding	Meeting	Approaching	Below	
Qur'an	Recognizes the alphabet with the given vowels in Arabic text					
	Write the Arabic alphabet					
Pillars of Iman	Identifies oneself and others as Allah's creation					
	Narrates simple short stories on the early years of Prophet Muhammad(S.A.W)					
Devotional acts	Demonstrates the postures in performing *Swalah*					
Moral teaching	Demonstrates appropriate ablution manners					
	Practices Islamic manners of eating					
Places of worship	Names other places of worship					
Islamic Festival	Describe activities related to Eid as an Islamic festival					

G. Name of assessor .....
Signature:……
Date.....
Name of Head Teacher:.....
Signature .....
Date……..…….……
Name of parent.....
Sign.....
Date.....

Appendix 3: Preschool Dimension Mastery Questionnaire (DMQ 18)

Your Use of the Dimensions of Mastery Questionnaire (DMQ 18) Form

Please email this form to Krisztian Jozsa (jozsa@edpsy.u-szeged.hu) or Hua-Fang Liao (hfliao@ntu.edu.tw) and to the researcher who is the contact person for the translation you would like to use (see the contact person's name and email address in **Appendix D**, List of the Available Translations.

Date: _____

Names of principal investigators (printed or typed):

_____ _____

_ _____

Organization: _____

Address: _____

E-mail address: _____

DMQ 18 language and age version(s) that you plan to use: _____

Age(s) and approximate numbers of participants/children: _____

Who do you plan to ask to rate the children/youth? (check YES for all you plan to use)

Mother:	- Yes	- No
Father:	- Yes	- No
Child Self-report:	- Yes	- No
Teacher/caregiver:	- Yes	- No

Other characteristics of the sample(s) (ethnicity, language, risk factors, etc.):

_____

_____

_____

Main research question(s) or purpose(s):

_____

_____

_____

Appendix 3b: Preschool Dimension Mastery Questionnaire (DMQ 18)

Childs ID_____Age: Yrs _____ Months_____
Circle one: Boy___ __ Girl ____ Today's Date_____
Rater's Relationship to Child: Mother_____Father___ (others Please specify)____
Please CIRCLE the number that best indicates how typical each statement is of this child's recent behaviour. Children vary; most are motivated to do some things but not others. Note that some items may not be typical for a child his or her age, so it is okay to use a "not like this child" rating. Please try to answer all questions even if you are not sure.

		NOT AT ALL LIKE THIS CHILD				**EXACTLY LIKE THIS CHILD**
1.	Repeats a new skill until he or she can do it	1	2	3	4	5
2.	Smiles broadly after finishing something	1	2	3	4	5
3.	Tries to do well at motor activities	1	2	3	4	5
4.	Solves problems quickly	1	2	3	4	5
5.	Seems sad or ashamed when does not accomplish a goal	1	2	3	4	5
6.	Tries hard to make other children feel better if they cry or seem sad	1	2	3	4	5
7.	Tries to do and say things that keep other children interested	1	2	3	4	5
8.	When talking with adults, tries to keep them interested	1	2	3	4	5
9.	Gets frustrated when not able to complete a challenging task	1	2	3	4	5
10.	Is very good at doing most things	1	2	3	4	5
11.	Shows excitement when he or she is successful	1	2	3	4	5
12.	Tries to do well in physical activities even when they are challenging	1	2	3	4	5
13.	Gets frustrated when does not do well at something	1	2	3	4	5
14.	Tries to complete tasks, even if it takes a long time to finish	1	2	3	4	5
15.	Tries hard to interest adults in playing with him or her	1	2	3	4	5
16.	Protests after failing at something	1	2	3	4	5
17.	Tries to complete toys like puzzles even if it takes hard work	1	2	3	4	5
18.	Gets excited when he or she figures something out	1	2	3	4	5
19.	Gets angry if cannot do something after trying hard	1	2	3	4	5
20.	Does things that are difficult for children for his or her age	1	2	3	4	5
21.	Is pleased when solves a challenging problem	1	2	3	4	5
22.	Tries hard to get adults to understand him or her	1	2	3	4	5

		NOT AT ALL LIKE THIS CHILD				EXACTLY LIKE THIS CHILD
23.	Works for a long time trying to do something challenging	1	2	3	4	5
24.	Won't look people in the eye when tries but cannot do something	1	2	3	4	5
25.	Tries to understand other children	1	2	3	4	5
26.	Repeats skills like jumping or running until he or she can do them	1	2	3	4	5
27.	Does most things better than other children his or her age	1	2	3	4	5
28.	Tries hard to make friends with other kids	1	2	3	4	5
29.	Will work for a long time trying to put something together	1	2	3	4	5
30.	Smiles when he or she makes something happen	1	2	3	4	5
31.	Understands things well	1	2	3	4	5
32.	Tries to get included when other children are playing	1	2	3	4	5
33.	Tries to figure out what adults like and don't like	1	2	3	4	5
34.	Looks away when tries but cannot do something	1	2	3	4	5
35.	Tries to keep play with other kids going for a long time	1	2	3	4	5
36.	Tries hard to get better at physical skills	1	2	3	4	5
37.	Tries hard to understand my feelings and those of other adults	1	2	3	4	5
38.	Tries hard to improve his or her skill at throwing or kicking	1	2	3	4	5
39.	Withdraws after trying but not succeeding	1	2	3	4	5

Appendix 4

Appendix 4: Hojaji Ya Motisha Kwa Shule Ya Chekechea (DMQ 18)

Kitambulisho cha Mtoto Umri_____ Miaka: _____ Miezi_____
Viringa (Chagua) moja: □ Mvulana □Msichana Tarehe ya Leo_____
Uhusiano wa Anayejaza na mtoto: Mama_____ Baba_____ Mwingine (Eleza Uhusiano)_____

Tafadhali VIRINGA nambari inayoafiki vyema jinsi kila kauli inavyoendana na tabia ya hivi karibuni ya mtoto huyu. Watoto hutofautiana, wengi wana motisha wa kufanya mambo fulani na sio vingine. Fahamu fika kuwa kuna baadhi ya mambo Kwenye hojaji hii yasiyoendana na mtoto wa umri wake kwa hivyo ni sawa kutumia kauli Kama "sio kwa mtoto huyu" kiviwango. Tafadhali jaribu kujibu maswali yote katika hojaji hii hata kama huna hakika.

		SIO KAMA MTOTO HUYU			**KAMA MTOTO HUYU**	
1.	Anarudia kipengele kipya cha ujuzi mpaka aweze kukifanya	1	2	3	4	5
2.	Anatabasamu sana pindi amalizapo kufanya jambo Fulani	1	2	3	4	5
3.	Anajaribu kufanya vyema katika shughuli za miondoko.	1	2	3	4	5
4.	Anatatua matatizo kwa haraka.	1	2	3	4	5
5.	Anaonekana kuwa na huzuni au kuaibika asipofikia lengo	1	2	3	4	5
6.	Anajaribu sana kuwafanya watoto wengine wajisikie vizuri wakilia au wakihuzunika.	1	2	3	4	5
7.	Anajaribu kufanya au kusema mambo ambayo huwapendeza watoto wengine.	1	2	3	4	5
8.	Anapozungumza na watu wazima hujaribu kuwafanya wapendezwe na	1	2	3	4	5
9.	Anakwazika anaposhindwa kukamilisha shughuli yenye changamoto kwake	1	2	3	4	5
10.	Ni mzuri sana kwa kufanya mambo mengi.	1	2	3	4	5
11.	Anaonyesha furaha anapofanikiwa kutekeleza jambo Fulani.	1	2	3	4	5
12.	Anajaribu kufanya vyema katika shughuli za kunyoosha viungo hata ingawa ina changamoto.	1	2	3	4	5
13.	Anakwazika akikosa kufanya vyema katika jambo Fulani.	1	2	3	4	5
14.	Anajaribu kutamatisha majukumu hata kama yatamchukua muda mrefu.	1	2	3	4	5
15.	Anajaribu sana kuwapendeza watu wazima wacheze naye	1	2	3	4	5
16.	Anazusha asipofaulu kufanya jambo fulani.	1	2	3	4	5
17.	Anajaribu kutamatisha michezo kama ya jeduali hata kama itamgharimu kazi ngumu.	1	2	3	4	5
18.	Anafurahi anapofahamu jambo	1	2	3	4	5
19.	Anakasirika akishindwa kufanya jambo baada ya kujitahidi sana	1	2	3	4	5
20.	Anafanya vitu vilivyo vigumu kwa watoto wa umri wake	1	2	3	4	5
21.	Anaridhika anapotatua tatizo lenye changamoto.	1	2	3	4	5
22.	Anajaribu sana kuwafanya watu wazima wamuelewe	1	2	3	4	5

		SIO KAMA MTOTO HUYU			KAMA MTOTO HUYU	
23.	Hufanya kazi kwa muda mrefu akijaribu kufanya jambo lenye changamoto	1	2	3	4	5
24.	Hawaangalii watu machoni anapojaribu na kushindwa kufanya jambo	1	2	3	4	5
25.	Anajaribu kuwaelewa watoto wengine.	1	2	3	4	5
26.	Anarudia mbinu kama kuruka au kukimbia mpaka aweze kuvifanya	1	2	3	4	5
27.	Anafanya mambo mengi vyema kuliko watoto wengine wa umri wake	1	2	3	4	5
28.	Anajaribu sana kufanya urafiki na watoto wengine	1	2	3	4	5
29.	Anatumia muda mwingi akijaribu kufanya jambo fulani	1	2	3	4	5
30.	Anatabasamu anapofaulu kutekeleza jambo fulani	1	2	3	4	5
31.	Anaelewa mambo vyema.	1	2	3	4	5
32.	Anajaribu ajumuishwe kwa watoto wengine wanapokuwa wakicheza	1	2	3	4	5
33.	Anajaribu kung'amua ni kipi wakipendacho watu wazima na ni kipi wasichokipenda.	1	2	3	4	5
34.	Anaangalia kando anapojaribu ila hawezi kufanya jambo fulani	1	2	3	4	5
35.	Anajaribu kuendeleza mchezo na watoto wengine kwa muda mrefu	1	2	3	4	5
36.	Hujaribu sana kujiboresha katika mbinu za kunyoosha viungo vya kimwili	1	2	3	4	5
37.	Anajaribu sana kuelewa hisia zangu na zile za watu wazima wengine.	1	2	3	4	5
38.	Anajaribu sana kuboresha mbinu zake katika urushaji au upigaji teke	1	2	3	4	5
39.	Anajiondoa baada ya kujaribu na kutofaulu.	1	2	3	4	5

Appendix 5

Appendix 5: School-age Motivation Questionnaire (by Adult-rating)

School-age Motivation Questionnaire (by Adult-rating)

Child's ID:_____; Age:____years; Gender: □boy, □girl; Today's date:

Rater's relationship to child: □mother, □father, □teacher, □other (please specify) _____

Please CIRCLE the number that best indicates how typical each statement of the 41 items is of this child's recent behavior. Children vary; most are motivated to do some things but not others. Note that some of the questions may not be typical of a child his or her age, so it is okay to use a "not like this child" rating. Please try to answer all questions even if you are not sure.

		NOT AT ALL LIKE THIS CHILD				EXACTLY LIKE THIS CHILD
1.	Works on a new problem until he or she can do it	1	2	3	4	5
2.	Is pleased with self when finishes something challenging	1	2	3	4	5
3.	Tries to do well at athletic games	1	2	3	4	5
4.	Solves problems quickly	1	2	3	4	5
5.	Seems sad or ashamed when he or she doesn't accomplish a goal	1	2	3	4	5
6.	Tries hard to make other children feel better if they seem sad	1	2	3	4	5
7.	Tries to say and do things that keep other children interested	1	2	3	4	5
8.	Often discusses things with adults	1	2	3	4	5
9.	Gets frustrated when not able to complete a challenging task	1	2	3	4	5
10.	Is very good at doing most things	1	2	3	4	5
11.	Gets excited when he or she is successful	1	2	3	4	5
12.	Tries to do well in physical activities even when they are challenging	1	2	3	4	5
13.	Gets frustrated when does not do well at something	1	2	3	4	5
14.	Completes school work, even if it takes a long time	1	2	3	4	5
15.	Tries hard to interest adults in his or her activities	1	2	3	4	5
16.	Protests after failing at something tried hard to do	1	2	3	4	5
17.	Tries to figure out all the steps needed to solve a problem	1	2	3	4	5
18.	Gets excited when he or she figures something out	1	2	3	4	5
19.	Tries to get adults to see his or her point of view	1	2	3	4	5
20.	Does things that are difficult for kids his or her age	1	2	3	4	5
21.	Is pleased when solves a problem after working hard at it	1	2	3	4	5
22.	Tries hard to get adults to understand him or her	1	2	3	4	5

		NOT AT ALL LIKE THIS CHILD				EXACTLY LIKE THIS CHILD
23.	Works for a long time trying to do something challenging	1	2	3	4	5
24.	Won't look people in the eye when tries but cannot do something	1	2	3	4	5
25.	Tries hard to understand other children	1	2	3	4	5
26.	Repeats sports skills until he or she can do them better	1	2	3	4	5
27.	Does most things better than other kids his or her age	1	2	3	4	5
28.	Tries hard to make friends with other kids	1	2	3	4	5
29.	Will work for a long time trying to solve a problem for school	1	2	3	4	5
30.	Smiles when succeeds at something he or she tried hard to do	1	2	3	4	5
31.	Understands things well	1	2	3	4	5
32.	Tries to get included when other kids are doing something	1	2	3	4	5
33.	Tries to find out what adults like and don't like	1	2	3	4	5
34.	Looks away when tries but cannot do something	1	2	3	4	5
35.	Tries to keep things going for a long time when playing with other kids	1	2	3	4	5
36.	Tries hard to get better at sports	1	2	3	4	5
37.	Tries hard to understand the feelings of adults	1	2	3	4	5
38.	Tries hard to improve his or her ball-game skills	1	2	3	4	5
39.	Withdraws after trying but not succeeding	1	2	3	4	5
40.	Prefers to try challenging problems instead of easy ones	1	2	3	4	5
41.	Gets angry if cannot do something after trying hard	1	2	3	4	5

Appendix 6

Appendix 6: Emotion Observation Score Sheet

Date of Session 1: …….Date of Session 2: ……

Name:……. ID:…….

A: Most intense emotion. + = positive, 0 = neutral, - = negative

B: Intensity of emotion. *Positive emotion*: 1 = low positive (e.g.,closed mouth smile), 2 = moderate positive (e.g.,open mouthed smile), 3 = high positive (e.g.,smile & positive vocalization or clapping/excited body); **OR** *Neutral emotion*: 0; **OR** *Negative emotion*: 1 = low negative (e.g.,slight frown), 2 = moderately negative (e.g.,clearly angry or sad face), 3 = high negative (e.g.,angry or sad face & negative vocalization or crying).

C: Persistence. Approximate percentage focused on trying to do the task:
1 = 0-19%, 2 = 20-39%, 3 = 40-59%, 4 = 60-79%, 5 = 80-100%

	Emotion		
Tasks	**A:** Most intense emotion	**B:** Intensity	**C:** Persistence
Number knowledge Alphabet knowledge Letter search			
1 Easy 2 Moderately challenging 1 3 Moderately challenging 2 4 Hard Number Search			
1 Easy 2 Moderately challenging 1 3 Moderately challenging 2 4 Hard Picture memory			
1 Easy 2 Moderately challenging 1 3 Moderately challenging 2 4 Hard Card sorting			
1 Easy 2 Moderately challenging 1 3 Moderately challenging 2 4 Hard			

Notes:

……

Appendix 7

Appendix 7: Childhood Executive Functioning Inventory (CHEXI) for Parents and Teachers

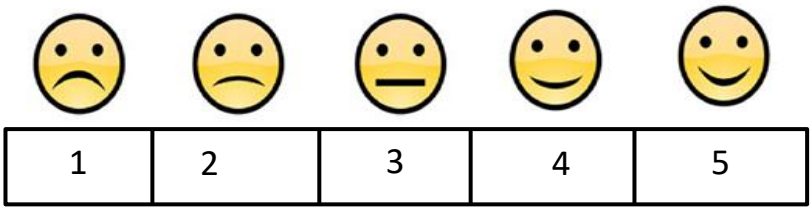
Below, you will find a number of statements. Please read each statement carefully and after that indicate how well that statement is true for the child. You indicate your response circling one of the numbers (from 1 to 5) after each statement.

Definitely not True -1	Not true -2	Partially not true -3	True - 4	Definitely true - 5

1	Has difficulty remembering lengthy instructions	1	2	3	4	5
2	Seldom seems to be able to motivate him/herself to do things something that he/she does not want to do.	1	2	3	4	5
3	Has difficulty remembering what he/she is doing in the middle of an activity.	1	2	3	4	5
4	Has difficulty following through on less appealing tasks unless he/she is promised a type of reward for doing so.	1	2	3	4	5
5	Has the tendency to do things without thinking of what could happen	1	2	3	4	5
6	When asked to do several things, he/she only remembers the first or last	1	2	3	4	5
7	Has difficulty coming up with a different way to solving a problem when he/she get stuck	1	2	3	4	5
8	When something needs to be done, he/she often distracted by something more appealing.	1	2	3	4	5
9	Easily forget what he/she is asked to fetch.	1	2	3	4	5
10	Gets overly excited when something special is going to happen (e.g.,going on a field trip, going to a party)	1	2	3	4	5
11	Has clear difficulties doing things he/she finds boring.	1	2	3	4	5
12	Has difficulty planning for an activity (e.g.,remembering everything necessary for a field trip or things needed for school.)	1	2	3	4	5
13	Has difficulty holding back his/her activity despite being told to do.	1	2	3	4	5
14	Has difficulty carrying out activities that require several steps (e.g.,for younger	1	2	3	4	5

	children, getting completely dressed without reminders; for older children, doing homework independently.)					
15	In order to be able to concentrate, he/she must find the task appealing	1	2	3	4	5
16	Has difficulty refraining from smiling or laughing in a situation where it is inappropriate.	1	2	3	4	5
17	Has difficulty telling a story about something that has happen so that others may easily understand	1	2	3	4	5
18	Has difficulty stopping an activity immediately upon being told to do so. For example, he/she need to jump a couple of extra time or play on a computer little bit longer after being told to stop.	1	2	3	4	5
19	Has difficulty understanding verbal instruction unless he/she is also shown how to do something	1	2	3	4	5
20	Has difficulty with tasks or activities that involve several steps.	1	2	3	4	5
21	Has difficulty of thinking ahead or learning from experience	1	2	3	4	5
22	Act in a wilder way compared to other children in the group (e.g., at a birthday party or during a group activity)	1	2	3	4	5
23	Has difficulty doing things that require mental effort, such as counting backwards.	1	2	3	4	5
24	Has difficulty keeping things in mind while he/she is doing something else.	1	2	3	4	5

Appendix 8: The Task-Motivation Questionnaire



Introduction of the Smile Scale:

"During this game, I will ask you a couple of questions using a special scale. Here is how it works. See all the faces [point to the faces on the scale]? See how some of the faces are frowning, and some are smiling? For example, look at this face [point to face 1]. This face is making a **big** frown - that means I really **do not** like something. This face has a **little** frown [point to face 2] – that means I **dislike** something a **little bit**. Look at this face [point to face 5]. This face has a **big** smile - that means I **really like** something. This face has a **little** smile [point to face 4] – that means I like something a **little bit**. Look at this face [point to face 3]. This face is **not** smiling **or** frowning, so that means I think something is **just okay**."

Practice items:

1. "Which face should I point to if I told you that I **do not like chips**?" [Wait for child's response]

"Yes, I would point to the face making a big frown [point to face 1] because I do not like Brussels sprouts." [Or: "That is a good guess, but I would point to the face making a big frown [point to face 1] because I do not like chips."]

"Okay, try this one - which face should I point to if I told you that I **like** to jump rope?" [Wait for child's response]

"Yes, I would point to the face making a big smile [point to face 5] because I like to jump rope." [Or: "That is a good guess, but I would point to the face making a big smile [point to face 5] because I like to jump rope."]

1. "Okay, let us do one more. Which face should I point to if I told you I think the colour green is **just okay**?" [Wait for child's response]

"Yes, I would point to this face that is not smiling or frowning [point to face 3] because that means I think something is just okay." [Or: "That is a good guess, but I would point to this face that is not smiling or frowning [point to face 3] because that means I think something is just okay."]

"All right, we will use this again in a little bit, but now we are going to play some computer games"

Rating each game using the Smile Scale:

"Okay, now I want you to point to the face that shows me what you thought about this game: Remember this face means you **do not like** this game [point to 1], this face means you **disliked** this game **a little** [point to 2], this face means you thought the game was **just okay** [point to 3], this face means you **liked** the game **a little** [point to 4], and this face means you **like the game[point to 5]. Okay, what did you think about the game-whatever you think is fine."**

Appendix 9: Standardised Grade One Examinations (Kenya National Examination Council, 2021)

THE KENYA NATIONAL EXAMINATIONS COUNCIL

Monitoring Learner Achievement at Primary School Level

ENGLISH - GRADE 1

Learner's name: .....

Learner's Admission No: .....

INSTRUCTIONS TO LEARNERS

Answer all the questions in this paper

FOR OFFICIAL USE ONLY

SCORING GRID (35 MARKS)

	Writing											
QUESTION	Part 1	Part 2	1a	1b	1c	1d	2a	2b	2c	2d	3a	3b
MARK (S)	5	5	1	1	1	1	1	1	1	1	1	1
SCORE												

3c	3d	4a	5a	6a	6b	6c	7a	7b	8a	8b	8c	9a	9b	9c	Total
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

SECTION B:

TASK 1: WRITING

Part 1: Dictation

_____

_____

_____

_____

_____

Part 2: Guided Writing

Look at the picture below

Write five things you can see

a)_____

b) _____

c) _____

d)_____

e) _____

TASK 2: READING COMPREHENSION

Read the story below and then fill the gaps.

The Lost Bag

Ali did not see his bag. He was sad. He cried. His mother said, I am sorry Ali. We will buy a new bag

a) Ali did not see his _____

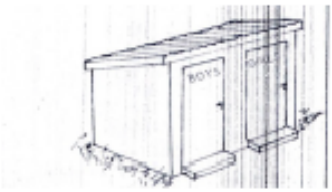
b) His mother was _____. (sorry, sad)

c) The story is about the _____ bag. (lost, new)

d) Ali will be _____ to get a new bag. (happy, sad)

2. Read the story below and then fill the gaps.

School Toilets



Our school has two toilets. One toilet is for boys. One toilet is for girls. The toilets are clean. We go to the toilets. We wash our hands with soap and water.

a) Our school has _____ toilets.

b) We wash our hands with _____ and water.

c) We wash our hands to make them _____. (dirty, clean)

d) The story is about _____ (toilets, home)

THE KENYA NATIONAL EXAMINATIONS COUNCIL

Monitoring Learner Achievement at Primary School Level

MATHS - GRADE 1

Learner's name: .....

Learner's Admission No: .....

INSTRUCTIONS TO LEARNERS

1. This paper has 20 questions
2. Answer all the questions in this paper

Time: 1 hour

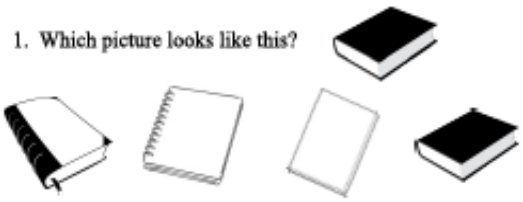
FOR OFFICIAL USE ONLY

SCORING GRID

QUESTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Score																				

TOTAL SCORE $\frac{x}{20}$

1. Which picture looks like this?



2. Which are less?

3. Circle the smallest cup.

4. Fill in.

Number	Objects
2	◯ ◯
5	

5. 18 is _____ tens _____ ones.

6. Put together

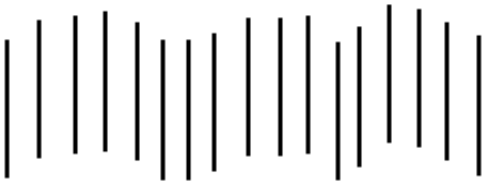
 and  is _____

7. 9 bananas take away 3 bananas is _____ bananas.

8. Fill in the missing number.

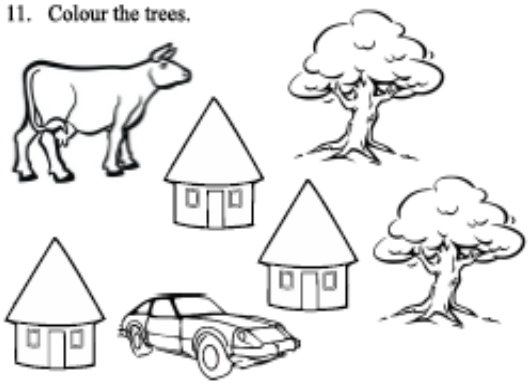
12, 14, 16, ____, 20

9. Count and write the number of sticks. _____



10. Which picture looks like this?

11. Colour the trees.



12. Match the same picture.

13. Which one holds more?

14. Use the shapes □ and △ to draw patterns

___ ___ ___ ___ ___ ___

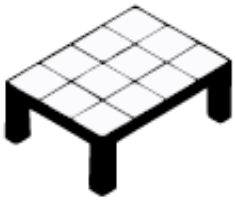
15. Draw the next picture in the pattern.

_____

16. Which spoon is shorter?

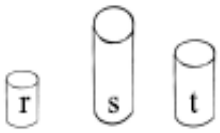
17. Which is heavier?

18. How many small boxes are on the table?_____



19. Which is a coin?

20. Arrange from big to small the objects given by the teacher.



THE KENYA NATIONAL EXAMINATIONS COUNCIL

Monitoring Learner Achievement at Primary School Level

KISWAHILI - GREDI 1

JINA LA MWANAFUNZI .....

NAMBARI YA USAJILI .....

MAAGIZO KWA MWANAFUNZI

1. Karatasi hii ina mazoezi matatu
2. ZOEZI 1: Ufahamu wa kusoma
3. ZOEZI 2: Matumizi ya Lugha
4. ZOEZI 3: Kuandika
5. Jibu maswali zote kwa lugha ya Kiswahili

Muda: Saa 1

KWA MTAHINI JEDWALI LA ALAMA

	UFAHAMU WA KUSOMA											
SWALI	1	2	3	4	5	6	7	8	9	10	11	12
UPEO	1	1	1	1	1	1	1	1	1	1	1	1
ALAMA												

	MATUMIZI YA LUGHA												
SWALI	13	14	15	16	17	18	19	20	21	22	23	24	25
UPEO	1	1	1	1	1	1	1	1	1	1	1	1	1
ALAMA													

	MATUMIZI YA LUGHA										
SWALI	26	27	28	29	30	31	32	33	34	35	**JUMLA**
UPEO	1	1	1	1	1	1	1	1	1	1	
ALAMA											

ZOEZI 1

UFAHAMU WA KUSOMA

Soma hadithi hii na ujibu maswali

Kobe na Sungura walikuwa marafiki.Walipanda kabeji kumi. Kabeji zilimea.Kobe alienda shambani.Alipata kabeji tisa. Alishangaa. Kila siku kabeji ilipotea. Kobe alikasirika. Alijifunika majani ya kabeji. Alifanana na kabeji kubwa. Sungura aliona kabeji kubwa. Alichukua kabeji. Kumbe kabeji ilikuwa Kobe. Kobe alimshika Sungura. Sungura alilia. Alisema pole. Alisema atapanda kabeji.

1. Rafiki ya Kobe alikuwa nani? .....
2. Kobe alipanda kabeji ngapi? .....
3. Kwa nini Sungura alilia? .....
4. Sungura alipanda kabeji. Kobe ..... (alifurahi, alikasirika)

Soma hadithi hii na ujibu maswali.

Tanui na wenzake walinawa mikono. Walichukua chakula. Tanui alishika bakuli vibaya. Chakula kilimwagika. Alianza kulia. Wenzake walimwambia asilie. Walimpeleka Tanui kwa Mwalimu. Alimpatia chakula kingine. Tanui alifurahi. Alisema atashika bakuli vizuri.

5. Tanui na wenzake walinawa .....
6. Kwa nini chakula chaTanui kilimwagika? .....
7. Mwalimu alimpatia Tanui .....
8. Tanui akikosa kunawa mikono..... (ataanza kulia, atakuwa mgonjwa)

Soma hadithi hii kisha ujibu maswali.

Mimi ninaitwa Neli. Nyanya alinituma dukani. Alinipatia pesa. Niliweka pesa mezani. Nilichukua kikapu. Nilimwita kaka yangu. Tulitoka haraka. Njiani tulianzakucheza. Tuliona Nyanya anakuja. Tulikimbia dukani.Nilipata sikuwa na pesa. Nilianza kulia. Tulitafuta pesa. Hatukupata. Nyanya alifika dukani. Alisema niliacha pesa. Tulinunua unga. Tulirudi nyumbani. Nyanya alisema tusisahau vitu,

9. Nyanya alimtuma Neli wapi? .....
10. Kwa nini Neli na kaka yake walikimbia? .....
11. Kwa nini Neli aliacha pesa? .....
12. Neli aliweka pesa mezani.Alifaa kuziweka..... Ili asisahau. (mfukoni, kabatini)

ZOEZI 2

MATUMIZI YA LUGHA

13. Tazama picha, jaza nafasi

Kuk___

14. Tazama picha, jaza nafasi

Pa___

15. Jaza nafasi. Tumia herufi **a,o.**

S__m__

16. Tazama jina. Onyesha picha.

Raba _____ 

Kitabu 

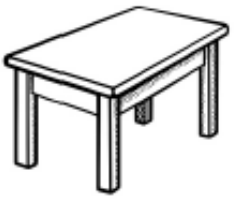
Kalamu 

17.  Hii ni picha ya _____.

18.   **Ndizi mbili.**

Ndizi _____.

19. Tazama picha andika neno.

 _____

20. Tazama picha. Panga herufi kuunda neno.

rual _____

21. Jaza nafasi.

Kam lro ni Jumanne, kesho ni _____ (Jumapili, Jumatano).

22. Panga maneno kuunda sentensi.

Amani kikombe anaosha

_____

23. Ni kitu gani hakitumiwi darasani? Pigia mstari.

Kalamu Jembe Ubao

24. Tazama picha. Jaza nafasi.

Kiti

V_____

25. Tazama picha, jaza nafasi

Mtoto _____ (anacheza, anasoma)

ZOEZI 3

SEHEMU YA KUANDIKA: IMLA

Mwalimu atasoma maneno. Andika.

26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____

Appendix 10: Interview Guide

Pre-school teachers

1. Describe how you admit children in pre-school 1
2. What is the minimum requirement for admission?
3. How do you promote them to the next class?
4. List records you maintain for the students
5. Which preschool curriculum is offered in this school?
6. Which documents do you handover to the next preschool teacher in preschool II and grade 1
7. What is your definition of school readiness?
8. Who is the most crucial partner during school readiness
9. What are the possible intervention procedures to enhance school readiness

Grade 1 Teachers

1. In your opinion, what is school readiness?
2. What are the minimum requirements to admit a child to grade 1?
3. What are the challenges that children face during the first week of admission in grade 1
4. In case of challenges, what are the possible intervention strategies
5. Are there tools that you fill in during the grade 1 assessment?
6. How often do you speak with a preschool teacher who taught your current students

ECD leaders at the County Level

1. What is the policy of the county for the assessment of school readiness?
2. What curriculum do you advocate for the county?
3. What is the minimum qualification of preschool teachers in your county?
4. In case of poor pre-school performance in a pre-school, what approaches do you adopt?
5. What documents will you expect preschool teachers to hand over to the grade 1 teachers?

Appendix 11: Permission to Conduct Research in Kenya
Ethical Approval from Institutional Review Board of University of Szeged

University of Szeged
Institutional Review Board
Doctoral School of Education

6722 Szeged, 30-34 Petőfi S. Av., Hungary
Phone/fax: +36 62 544-032

Stephen Amukune
PhD Student: Doctoral School of Education
Reference number: 18/2018
Subject: Ethical evaluation of a research project

ETHICAL APPROVAL

The Insitutional Review Board (IRB) of the Doctoral School of Education, University of Szeged has recently reviewed your application for an ethical approval (Title of the Research Project: " Mastery Motivation and Executive Functions Factors: Enhancement of School Readiness in Kenya", senior researcher: Prof. Dr. Krisztián Józsa).
This proposal is deemed to meet the requirements of the ethical conducts on social research with human subjects of the Doctoral School of Education, University of Szeged.

IRB decision: approved

Justification: The research project meets the requirements of the professional-ethical criteria of the social research including human subjects within the field of educational science. Participation in data collection is voluntary, the identification of the students is not possible to this research. The students and their parents will be informed about the main goals of the research project. Procedure of the data collection does not harm their privacy law, it does not have an impact on the students' mental or physical health. Data cannot be handled by persons to whom they are not concerned.

In a summary, full ethical approval has been granted.

We wish you all the best for the conduct of the project.

Prof. Dr. Bettina Pikó
IRB coordinator

Date: 16th December, 2018

Ethical Approval from Pwani University Research Board (Ethical approval institution accredited by NACOSTi)

NACOSTI ACCREDITED

ERC/PhD/004/2020

Pwani UNIVERSITY
P.O. Box 195-80108
Kilifi, Kenya.

REF: ERC/PhD/004/2020 Date: 20th Mar 2020

TO: Mr. Stephen Amukune

Dear Sir/madam

RE: STUDY TITLE: Mastery motivation and executive functions as School readiness factors: Enhancement of School readiness in Kenya.

This is to inform you that ***Pwani University Ethics Review Committee*** has reviewed and approved your above research proposal. Your application approval number is **ERC/PhD/004/2020.**The approval period is ***20th Mar, 2020 – 19th Mar, 2021***. This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***Pwani University Ethics Review Committee***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***Pwani University Ethics Review Committee*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***Pwani University Ethics Review Committee*** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***Pwani University Ethics Review Committee***.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Chair, IERC

Pwani UNIVERSITY
Ethics Review Committee,
Pwani University, www.pu.ac.ke, email: ercpu@pu.ac.ke, Ladno@pu.ac.ke tell: 0719 182218, 0720785781
The ERC, Giving Integrity to Research for Sustainable Development

NACOSTI ACCREDITED

ERC/PhD/004/2020

ETHICS REVIEW COMMITTEE

ACCREDITTED BY THE NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION (NACOSTI, KENYA)

CERTIFICATE OF ETHICAL APPROVAL

THIS IS TO CERTIFY THAT THE PROPOSAL SUBMITTED BY:

STEPHEN AMUKUNE

REFERENCE NO:
ERC/PhD/004/2020

ENTITLED:

Mastery motivation and executive functions as School readiness factors: Enhancement of School readiness in Kenya.

TO BE UNDERTAKEN AT:
KILIFI COUNTY, KENYA

FOR THE PERIOD
FROM: 03/20/2020 TO: 03/19/2021

HAS BEEN **APPROVED** BY THE ETHICS REVIEW COMMITTEE

AT ITS SITTING HELD AT PWANI UNIVERSITY, KENYA

ON THE 03/19/2020

CHAIRMAN	SECRETARY	LAY MEMEBER

Ethics Review Committee,

Pwani University, www.pu.ac.ke, email: ercnc@pu.ac.ke, info@pu.ac.ke tel: 0719 182218, 0728785791

The ERC, Giving Integrity to Research for Sustainable Development