

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

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INTRODUCTION

School readiness predicts both school and life success; therefore, its precise assessment and enhancement are critical (Barrett et al., 2017; Russo et al., 2019). One of the domains of school readiness that is rarely fully assessed is Approaches to Learning (ATL; Józsa et al., 2017; Kagan et al., 1995). Other literature surveys on ATL (e.g. Snow & Van Hemel, 2008) have also reported that this area is still under-researched, least understood, but the most important since it is at the core of cognitive and socio-emotional interactions (Bustamante et al., 2017; Kagan et al., 1995; Razza et al., 2015). Recently researchers have identified both Mastery Motivation(MM) and Executive Functions(EF) as crucial components of ATL (e.g. Barrett et al., 2017; Buek, 2019; Duncan et al., 2018; Józsa & Barrett, 2018). Failure to assess motivation and EF 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 EF; thus difficult to provide individualised intervention (Willoughby et al., 2019). Additionally, both motivation and executive functioning contribute immensely to the process quality of early childhood programs (Amukune, 2021). Therefore, parent and teacher ratings are typically utilised (Zhang et al., 2021). However, the value of parent and teacher reports depends on the quality of information teachers and parents can produce. Consequently, direct, child-administered methods have been suggested to compensate for these weaknesses (Li et al., 2019). However, the majority of direct assessments are expensive and require trained examiners who are not available in Low and Middle-Income Countries (LMIC) such as Kenya. 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, to date, we are not aware of any tablet-based assessment of both MM and EF used in Kenya to address this challenge.

The study's overall goal is to enhance school readiness assessment by developing an Android app to measure pre-academic skills, MM and EF to complement existing tools. Secondly, to determine the contribution of MM and EF to academic performance in the Kenyan context. The first section of this paper addresses the Literature Review. The review covers the theoretical background of School readiness, MM, EF and their assessment procedures. Since this study is based on the theory of Approaches to learning (Kagan et al., 1995), the chapter also discusses the nexus between MM, EF and ATL as one of the domains of school readiness. An attempt is also made to identify empirical studies in ATL, MM, and EF and their relationship with academic performance and school readiness in literature.

Moreover, studies that suggest various intervention strategies are also provided to show the malleability of MM and EF. The chapter also provides some empirical studies in Kenya on school readiness. 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.

Before addressing the aims and methodology of the study, the paper addresses how Finding Out Children's Unique Strengths (FOCUS App; Józsa et al., 2017) was designed and developed to fit Kenya following the Education Design Research approach. Six empirical studies and 20 research questions were answered. However, one study did not have research questions; instead, it developed six research hypotheses and tested them.

LITERATURE REVIEW

Boivin and his colleague defined school readiness as a multidimensional concept composed of cognitive, language, executive functioning, behavioural, socio-emotional, and health characteristics that provide children with the capability to adjust and succeed in school settings (Boivin & Bierman, 2013). Boivin's definition closely matches Kagan, and her colleagues, who 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; US Department of Education, 2005). However, 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 ATL (e.g. Hyson, 2008; Barrett et al., 2018; McDermott et al., 2012; Meng, 2015) and socio-emotional skills (e.g. Denham et al., 2014). In addition, 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).

Although there are many tools for assessing school readiness, few are suitable for LMIC since most were normed in high-income western countries; they are expensive and require skilled or trained examiners (Pisani et al., 2018). Additionally, most tools normed in LMIC target school readiness program evaluations but do not support individual child interventions. 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 (EAPECD; 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 and MELQO, 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 ATL, but it is teacher-rated based on school assessments but cannot be used outside the school. Moreover, teacher or parent-rated 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 and does not measure motivation.

The 2000 U.S. National Education Goals Panel (Kagan et al., 1995) first introduced Approaches to Learning and the other five dimensions of school readiness in early childhood research, and due to its importance, it has attracted global attention (Zhang et al., 2021). ATL are 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 and Pianta, 2017). These attributes are closely connected to the construct of MM and EF (e.g. Barrett et al., 2017; Józsa & Barrett, 2018). Conceptually, in literature, different names refer to ATL, including working approach (Chen and 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). Research has demonstrated that positive ATL is linked with higher reading, math performance, lifelong learning, academic school readiness and long term academic performance (Beisly et al., 2020; Hyson, 2008; Sung & Wickrama, 2018).

Different methods have been used to assess ATL, such as teachers' reports, parent reports and direct assessment (Ackerman, 2018; Li et al., 2019), but in most cases, teacher's rating is the most preferred mode (Zhang et al., 2021). The most common ones include; the Preschool Learning Behaviors Scale (PLBS; McDermott, Leigh, and Perry 2002) and the Child Behaviour Rating Scale (CBRS), the Approaches to learning scale of the Early Childhood Longitudinal Study - Kindergarten Cohort's ECLS-K (Li-Grinning et al. 2010). 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 ATL using teacher/parent reports does not fully assess it (Józsa et al., 2017; Kagan et al., 1995, Li et al., 2019).

Despite this, scholars identify MM and EF as essential components of ATL, which lay a foundation for academic performance and school success (e.g. Barrett et al., 2017; Berhenke et al., 2011; Buek, 2019; Duncan et al., 2018; McClelland & Wanless, 2012). However, no studies have used them to assess ATL or their combined contribution to academic performance. MM is "the urge or psychological "push" to solve problems, meet challenges, and master ourselves and our world" (Barrett and Morgan, 2018, p.4). Compared to other motivation theories, MM is much broader. The focus of MM is on persistence when solving moderately challenging tasks and engagement with people and objects during learning (Busch-Rossnagel & Morgan, 2013). This is one reason MM is considered necessary in approaches to the learning dimension of school readiness (Fantuzzo et al., 2004). However, MM has not featured prominently in school readiness literature (Józsa & Barrett, 2018). In early childhood, MM is assessed by utilising 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); this is the focus of this study. Both cross-sectional and longitudinal research has demonstrated that MM, specifically cognitive persistence, can predict school performance (Józsa et al., 2019). It also predicted academic performance better than developmental scores in children with developmental disabilities (Gilmore & Cuskelly, 2009). In the case of maladjustment, mastery motivation can be enhanced using different strategies. Among them include the "One Step Ahead" approach (Mermelshtine, 2017) and the Pivotal Response Treatment approach (Koegel et al., 2012), encouraging autonomy and affective teaching (e.g., Sakiz, 2017).

Executive Functions (EF), on the other hand, play a critical role in school readiness (Blair & Razza, 2007), school success (Duncan et al., 2007), mental health (Diamond, 2005), physical health (Zelazo et al., 2016) and socio-emotional competence (Rhoades et al., 2009) among children. Evidence from neuroimaging findings has shown that the three components of EF, working memory, cognitive flexibility and inhibitory control, are critical in learning (Sung & Wickrama, 2018). Many methods have been used to measure executive functions in literature,

either behaviour-based or performance-based tasks (see Baggetta & Alexander, 2016 for review). Performance-based tasks are the gold standard in the assessment of executive functions. However, questionnaires are also available since ratings and direct measures have little correlation indicating they tap different aspects; availability of EF skills and their application at home or school (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). A much simpler one with 24 items, although not widely used, is the Childhood Executive Functioning Inventory (CHEXI: Thorell & Nyberg, 2008). There are commercially computer-based batteries of tests that are useful in assessing EF in LMICs. Executive function Touch (EF Touch) is another highly structured tool and can administer four EF tasks: Bubbles, Silly Sounds, Stroop and Spatial Conflict Arrows, and Pick the picture (Willoughby et al., 2019). Another tool is the Early Years Toolbox (EYT), a digital application assessing early self-regulation, executive function, language, and social development measures (Howard & Menush, 2017). Just like Mastery Motivation, EF can be enhanced using different methods. The most successful methods are the ones that adjust children's everyday experiences after identifying a child's emerging abilities (Howard & 2017). Such interventions applied in the child's daily activity have better ecological validity (Blair, 2017).

There has been much effort to develop a technology-based assessment to suit children (Csapó et al., 2014; Neuman & Neuman, 2019). 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 (Sammelmann et al., 2016). 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 EF-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 EF tablet assessments are affected by reaction time, which is a less relevant skill in EF assessment (Barrett et al., 2017). We agreed to develop a tablet-based android game-like app suitable for children in the Kenyan context to fill this gap.

DEVELOPMENT OF TABLET-BASED ASSESSMENT OF SCHOOL READINESS

We followed the Education Design Research (EDR) approach; analysis and exploration, design and construction, and Evaluation and Reflection to develop an app for assessing pre-academic skills, mastery motivation, and executive functions to complement the existing Kenya School Readiness Tool that does not assess those domains. At the needs and analysis stage, we firstly collected stakeholders' views and secondly, we carried out an intensive literature review to understand how other apps have captured school readiness assessments. As a result, we reviewed over 2038 records and identified 31 articles on the game based assessment of school readiness domains. However, out of the 31, only one addressed the construct of approaches to learning, precisely mastery motivation and executive functions (Amukune et al., 2022). Based on this finding, we agreed to use the design of the FOCUS app (Józsa et al., 2017) and adapt it to suit the Kenyan context.

FOCUS has 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 MM, operationalised as the child's persistence during moderately challenging tasks. This approach to measuring MM is based on Morgan et al. (1992), who developed a procedure for separating a child's ability from motivation. Finally, tasks 6 and 7 are primarily designed to assess EFs but can also provide MM 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.

In the design and construction stage, we reviewed Kenya's curriculum from preschool to grade 3 to identify whether our curriculum conforms with FOCUS App. Two approaches were adopted to accomplish this task; forward and backward curriculum analysis (Holtsch et al., 2016). We revised the code, audio, and images to suit the Kenyan context. For example, we translated American English to Kiswahili and English with a Kenyan accent. We also revised other sections that were not working correctly in the previous version, notably a language menu, data converter and data storage. FOCUS app is an in-house software developed using Java programming language. To modify the code, we used Android Studio 2019. 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 the program installed on the server.

The process of collecting data using the FOCUS app is straightforward. First, the examiner locates a comfortable room and quiet for the children and then informs the children, "we are going to play a game on the tablet". 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 MM (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. After the design and development were complete, we carried out several tests from January 2020 to spring 2022. 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 situations. Two studies during piloting formed part of the empirical studies that were done at the evaluation and reflection stage.

QUESTIONS AND METHODS OF THE EMPIRICAL STUDIES

The Logic of the Empirical Studies

The paper has six studies in total. Two empirical studies were conducted during the development of the FOCUS app. These studies covered the systematic literature review to identify the game based assessments of school readiness domains and two pilot studies at the evaluation and reflection stage of the app. The literature review aimed to identify and develop a form of direct assessment for school readiness that could be administered without the need for intensive training of examiners. Two empirical studies were done to develop two tools that are extremely important

in assessing MM and EF; the Preschool Dimension of Mastery Questionnaire(DMQ; Morgan et al., 2020) and the Childhood Executive Functioning Inventory (CHEXI; Thorell & Nyberg, 2008) respectively. Finally, two other empirical studies involved the assessment of MM, EF and academic performance using the questionnaires and the FOCUS App. The two studies aimed to determine the direct and indirect effect of MM and EF on children's academic performance during the transition to grade 1 and the predictive ability of MM and EF for school readiness when directly assessed and when rated using DMQ 18.

Research Questions

Research Questions for Study 1

Study 1. It was a Scoping Literature Review of Game-Based assessment of school readiness domains. The following are the research questions that it addressed.

1. What are the main characteristics of Game-Based Assessment (GBA) studies of school readiness domains?
2. Which countries have more studies in GBA of school readiness domains?
3. Which knowledge, skills or abilities related to 3-8-year-old school readiness are assessed?
4. Are these assessments done in schools or outside schools contexts?
5. What measurement type and instruments does each assessment adopt?
6. What are the psychometric properties of these tools?
7. What type of performance data analyses are employed by these studies?
8. Are these performance data analyses on the process or product data?
9. How is the outcome of the GBA used to enhance the development of school readiness?

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 had transitioned to grade 1.

1. What is the validity and reliability of the newly redesigned FOCUS app in Swahili to fit the Kenyan context?
2. Is there a relationship between pre-academic skills assessed using the FOCUS app and academic performance in Grade 1?
3. Is there a relationship between pre-academic skills and mastery motivation in preschool and grade 1?
4. Is there a significant difference in academic performance from preschool to school?
5. What is the predictive ability of the pre-academic skills task of the FOCUS app and academic performance in grade 1?

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 MM in the Kenyan context, especially among parents who were not competent in English.

1. What are the psychometric properties of the preschool Dimension of Mastery Questionnaire 18 when translated to Swahili in the Kenyan Context?

2. Is there a significant difference in the rating of the DMQ 18 by parents and teachers?
3. Is there a significant difference between male and female students concerning their Mastery Motivation in the Kenyan context?
4. Is there a significant difference between preschoolers who have met the age requirement for Preprimary II and those above the minimum age requirement?
5. Is there a significant difference between the DMQ 18 ratings of the Kenyan sample and the available preliminary norms?

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.

1. What is the factor structure of the Childhood Executive Functioning Inventory (CHEXI; Thorell & Nyberg, 2008) in the Kenyan context?
2. What is the measurement invariance of the CHEXI based on gender?
3. Are there EF deficits among Kenyan first-graders in public and private schools?
4. Is there an association between EF and academic performance among Kenyan First Graders?

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 theorised that both MM and EF are essential components of Approaches to Learning. Thus, we hypothesised as follows;

1. MM has positive independent effects on academic performance (Józsa and Morgan, 2014; Mercader et al., 2017)
2. EF skills directly affect academic performance (Cartwright, 2012; Kolkman et al., 2013).
3. MM directly affects EF skills (Becker et al., 2019; Hauser-Cram et al., 2014)
4. Executive function skills mediate the relationship between mastery motivation and academic Performance (Sung & Wickrama, 2018; Rash et al., 2016)
5. Children with low MM and high EF difficulties will have low academic performance (Józsa & Molnár, 2013).

Research Questions for Study 6

Study 6 compared Assessment of Approaches to Learning using the FOCUS app and Behavioural Ratings of MM and EFs. The following are the research questions for this study. What is the validity and reliability of the revised number and letter recognition for the assessment of pre-academic skills?

1. 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?
2. Determine the longitudinal growth of pre-academic skills from preschool to grade 2
3. Between the FOCUS app direct assessment of Mastery motivation and School DMQ 18, which had a better predicting power of academic performance in the Kenyan context?
4. What is the ability of pre-academic skills in the FOCUS app to predict academic performance in grade 1?

Methods

Research Design

The app's development followed the educational design research approach, while the other empirical studies adopted the longitudinal non-experimental design.

Sample

For study one, no samples were required since it was a scoping literature review. A total of 2098 records were scrutinised following (Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; 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. After some revisions to the app, the second pilot pursued the students that were assessed in pilot 1. Only 52 students progressed to grade 1, and 35 children either repeated or dropped out. However, both pilots were seriously interfered with by the pandemic, and it was not easy to collect data due to lockdowns and school closures. Study 3 aimed to assess MM and sampled 397 preschool children in preschool II, rated by 11 teachers. 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 DMQ 18. The second rating by the teachers was used to determine parallel forms reliability of the DMQ 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 MM and EF to the academic performance of grade 1 children. The teachers filled out the DMQ 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.

Data Collection

Before data collection, we obtained ethical clearance from the University of Szeged, Hungary and the National Council for Science and Technology and Innovations in Kenya. The adaptation of the FOCUS app to suit Kenya started in November 2018. The first pilot of the Preschool DMQ 18 in Kiswahili was done in January 2019, using the pre-primary II as the study sample. The Focus app in the Kenyan context was piloted in March 2019 and another pilot in 2020. Both sessions suffered interruptions due to COVID 19 pandemic. In March, we followed the same students in 2021, where we collected large data samples. After several tests of the FOCUS App, we noted missing gaps in the executive function tasks. In 2021 we reviewed the tasks and implemented a new converter 2022. The process of design, development and data collection using the FOCUS app has been continuous from 2019 to 2022.

Instruments

We used the preschool version of the DMQ 18 (DMQ; Morgan et al. 2020) English and Swahili versions to collect data on preschool mastery motivation. The FOCUS app was also used to collect data on MM as a direct assessment. Both instruments were helpful since we could compare the cognitive persistence scale from both tools. The Childhood executive functioning inventory (CHEXI; Thorell & Nyburg., 2008) collected data on executive functioning while the direct assessment was done using the FOCUS app. We also used the task motivation questionnaire to assess the interest and enthusiasm of children after the FOCUS tasks. A standardised 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. To record emotions during FOCUS tasks, we used the emotion observation score sheet (Józsa et al., 2017).

MAIN FINDINGS OF THE EMPIRICAL STUDIES

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. Beyond our expectations, our review revealed that only one study had focused on ATL, and Over 75% of the studies addressed academic performance. The intervention strategies focused on the curriculum subjects, especially math, reading and sciences, in a quasi-experimental design. There was no focus on other school readiness domains, such as ATL. From the outcome of this review, we identified only one study that addressed MM and EF combined that were previously designed for Hungarian and US cultures. 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. We also tested whether there was 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 MM 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. 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. Nevertheless, this test was practical to allow the examiners to use the FOCUS app at preschool to judge the child's performance in the future.

During the assessment of MM, both parents and teachers are often used to rate the children. Therefore, we compared parents' and teachers' ratings in the Kenyan context. The ratings of parents and teachers on the DMQ scale were significantly different except for cognitive persistence and mastery pleasure, meaning parents and teachers see children differently but agree on their thinking abilities. We also compared children aged 5-6 in pre-primary II (the required age in pre-primary 2) and those above age six on their MM. There was a significant difference in all subscales between children above the normative age for preschool II of 5-6 years and above six years, except for cognitive persistence. This indicates a cognitive risk of retaining older children in the class who are older than their peers. Therefore, children should be recruited and placed at the class level that best suits their age and peers.

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 tested differences in EF difficulties based on gender, age and school the child attended. Results showed no gender differences between boys and girls based on EF. Nevertheless, there were significant differences between different age groups and children from public and private schools. Young children were more likely to have more EF difficulties than older children in the same class. In general, children from private schools outperformed their peers from public schools in EF skills and academic performance. In addition, there was a close association between academic performance and EF skills. Children who had high EF difficulties performed poorly in academic performance. Therefore, EF difficulties were a significant predictor of academic performance.

We used structural equation modelling to investigate the contribution of MM and EF to the Academic performance of First Graders in the Kenyan context. Results showed that MM had a direct effect on academic performance and an indirect effect on executive functions. We tried whether there would also be an indirect effect between EF and academic performance through MM, but this hypothesis was not confirmed. Other authors have reported that the cognitive persistence of MM is the only subscale that has a direct impact on academic performance. However, mastery pleasure had a more substantial effect on academic performance than cognitive persistence in this study. Additionally, 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. This hypothesis showed higher chances of improving EF skills if MM is enhanced. Due to these significant effects between MM and EF, we grouped students according to whether they had low MM and EF skills. We tested whether these groups showed significant differences between categories with low MM and great EF difficulties and those with high MM and low EF difficulties. Students with low MM and high EF difficulties had a low academic performance. This result supports the idea that enhancing MM and EF skills can improve academic performance. We observed a difference of about 28% between children with low MM and great EF difficulties and children with high MM and low EF difficulties.

After the development, testing and validation of the FOCUS app, we collected a large sample to compare the assessment of MM using direct assessments in the FOCUS app and ratings using the preschool DMQ 18. We first explored whether the FOCUS app can assess pre-academic skills across different age groups and gender. Results 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. Next, we compared between assessment of MM using ratings and the FOCUS app task. Previous studies have shown that MM is a significant predictor of academic performance. We, therefore, compared the DMQ 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 DMQ 18, suggesting that the FOCUS app is a better tool that can be applied in the Kenyan context.

Application of Results

Recommendations for Teachers

1. FOCUS App promises to provide 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. In addition, the FOCUS app can help diagnose whether poor academic performance is due to low motivation or executive function difficulties and vice versa.
2. Children should be placed correctly based on age: pre-primary one at four years, pre-primary two at five years and grade 1 at six years, as recommended by the Ministry of Education. This is crucial so that learners can take advantage of cognitive persistence that develops among peers.
3. 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 how to address those challenges, especially from preschool to school.

4. Emphasis should be placed on classroom management especially targeting Math skills through lessons and daily school activities that focus on Executive function skills and Mastery Motivation. Since EF differs based on age, there is also a great need to offer differentiating teaching targeting individual learner needs, especially for young children learning with older peers. Teacher-training programmes need to provide specialised courses to empower teachers with skills to handle children during preschool to school transition

Recommendation for Policy

5. FOCUS app is valid and reliable and can complement Kenya School Readiness Tool in assessing school readiness in Kenya.
6. 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
7. 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 EF.
8. Prioritise Kiswahili as a language of instruction, especially in regions where it is spoken at home and school.

Suggestions for Further Research

Currently, the FOCUS app administers tasks based on the child's age. Although this is preferable to giving all children the same tasks, there are substantial individual differences even for children of the same age. For this reason, there is a need in the future to enable the FOCUS app to administer tasks based on the competence of the child. In addition, other modules could be added to the FOCUS menu to make it more adaptive to school readiness tests and provide visualised feedback to the stakeholders in real time. Specifically, a combination of pre-academic skills, MM and EF with a relevant enhancement strategy can be helpful for teachers and parents working in the LMICs.

Since the DMQ Swahili version (Amukune et al., 2021) and validated CHEXI for the Kenyan context (Amukune & Józsa, 2021) are available, there is a need to develop the CHEXI Swahili version. The CHEXI Swahili 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 for identifying EF deficits, e.g. the BRIEF, which can also be compared with the CHEXI using the Kenyan sample. Despite the utility of the FOCUS app, DMQ 18 and CHEXI, there is a need to carry out extensive sample data collection to obtain normative data to compare with. This data will assist teachers in diagnosing intervention procedures for children who perform poorly in academic performance.

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