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Approaches to Learning in Elementary Classrooms: Contribution of Mastery Motivation and Executive Functions on Academic Achievement

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This study examines the possible roles of mastery motivation and executive functions on academic achievement. Grade one children were selected using stratified random sampling. Teachers completed school versions of the Dimensions of Mastery Questionnaire (DMQ 18) and the Childhood Executive Functioning Inventory (CHEXI) to assess mastery motivation and executive functions, respectively. Standardized tests were used to assess academic achievement in Math, English and Kiswahili. The results indicated that mastery motivation, specifically cognitive persistence and mastery pleasure sub-scales, influence academic achievement directly and indirectly through executive functions. Furthermore, significant differences were found ranging from moderate to large effect sizes between those learners with high mastery motivation and low executive function difficulties and those with low mastery motivation and high executive function difficulties in academic achievement. Focusing on subject-specific curricular intervention alone is insufficient to enhance academic achievement and school success. Since mastery motivation and executive functions are malleable throughout life, intervention strategies to enhance them can improve approaches to learning, academic achievement and life success.

Keywords: academic achievement, approaches to learning, mastery motivation, executive functions, elementary classrooms

INTRODUCTION

Recent studies have focused on character traits and 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 achievement (e.g. Eskreis-Winkler et al., 2014) (Ribner, 2020). Given the diversity of learning environments that children experience, some key questions arise. Which individual traits

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contribute most to school readiness and academic success? (cf. Ribner, 2020). To account for individual differences in adaptation among learners, researchers tend to focus more on domain-general processes that account for how children learn instead of what they know, including domain-specific subject knowledge (Nesbitt et al., 2015). Some domain-general processes include motivation, self-regulation and persistence to support school success (e.g., Finch & Obradović, 2017). Several authors have pointed out that mastery motivation and executive functions are both critical components of approaches to learning and lay a foundation for academic achievement (Barrett et al., 2017; Buek, 2019). Here, approaches to learning refer to the attributes that help children learn, such as enthusiasm, self-regulation, persistence, motivation, interest, flexibility, initiative, reflection, attentiveness, cooperation, and independence (Li et al., 2019). Both persistence and enthusiasm when handling challenging tasks are the primary measures of mastery motivation and approaches to learning. In addition, mastery motivation shares characteristics with executive functions, another component of approaches to learning (Barrett et al., 2017). Thus, 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). However, authors have observed a paucity of research on the associations between motivation and executive functions (Finch & Obradović, 2017; Torgrimson et al., 2021) or mastery motivation as an intervening variable (MacPhee et al., 2018).

Mastery Motivation in Elementary Children

Mastery motivation is “the urge or psychological ‘push’ to solve problems, meet challenges, and master ourselves and our world” (Barrett & Morgan, 2018, p. 4). Mastery motivation focuses on persistence while solving moderately challenging tasks and engaging with people and objects during learning (Busch-Rossnagel & Morgan, 2013). It is composed of two major aspects; persistence or instrumental and affective, also known as expressive aspects. The persistence aspects of mastery motivation motivate the child to attempt a challenging task or skill. On the other hand, the affective aspect exhibits the emotions that the child displays during or after accomplishing the task. Persistence is the central focus because it directly impacts competence more than the expressive aspect. In addition, a child may or may not display the affective aspects since it is influenced by age and manifests itself in different manners as the child develops (Morgan et al., 2020). Therefore, mastery motivation is necessary for approaches that relate to the learning dimension of school readiness (Fantuzzo et al., 2004). Some studies have reported that persistence can mediate elementary school student's academic achievement and cognitive control (e.g. Sung & Wickrama, 2018). However, these studies used laboratory-based measures, and more studies are necessary to understand these associations (Józsa et al., 2017).

Mastery Motivation and Academic Achievement

Both cross-sectional and longitudinal studies have reported that mastery motivation can predict school achievement (Józsa et al., 2019; Józsa & Molnár, 2013). Longitudinally, the cognitive persistence scale in grade 4 predicted school-related skills, language and math, and grade point average (GPA) in grade 8 (Mokrova et al., 2013). Besides, Mercader et al. (2017) reported that mathematics achievement in the second grade was significantly predicted by persistence in completing a challenging task in preschool. Furthermore, some studies have reported that children with low socioeconomic status (SES) have a low mastery motivation approach to learning and academic skills (Sasser et al., 2017). The reason children from low SES backgrounds have low mastery motivation is also unclear; some researchers have remarked on the economic stress that their parents suffer, which denies children adequate opportunities for diversity and modelling due to financial constraints (Turner & Johnson, 2003). Since mastery motivation is malleable (McDermott et al., 2014) and students from families with a low SES benefit the most from such interventions (MacPhee et al., 2018), strategies for improving mastery motivation and executive functions in elementary school could help close the SES gap, especially with at-risk children. Despite these strengths, mastery motivation has received very little attention in the school readiness literature (Józsa & Barrett, 2018).

Executive Functions in Elementary School Children

The quantitative and qualitative values assigned to a student after the teaching and learning process indicate academic achievement and the ability of the brain to facilitate this process (Vermunt & Endedijk, 2011). Executive functions refer to “the ability to inhibit a well-learned but undesirable response (inhibitory control), keep thoughts in mind while problem-solving (working memory), and modify strategies to adjust to changing goals (cognitive flexibility)” (Józsa & Barrett, 2018, p. 83). Neuroimaging results have shown that executive function components, cognitive flexibility, inhibitory control and working memory are critical elements in learning (Sung & Wickrama, 2018), especially in mathematics (Clements & Sarama, 2019). 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, and participating in group activities (Clements & Sarama, 2019). Thus, strong executive functions support children’s approaches to learning (Sung & Wickrama, 2018).

Executive functions are chiefly assessed using laboratory-based measures, although demand for ratings has been seen among educational researchers (Camerota et al., 2018). Ratings have the advantage that they assess executive functions over an extended period, unlike laboratory measures. Additionally, ratings measure typical performance and application of executive function skills at school or home (Isquith et al., 2013; Toplak et al., 2013). However, laboratory measures and ratings show low correlation, suggesting they tap different aspects of executive functions. For example, laboratory measures assess the availability of the cognitive abilities in the child, while ratings measure the application in the child’s daily activities at home and school (Camerotal et al., 2018; Catale et al., 2013). Furthermore, laboratory measures have limited ecological validity, and the contextual demand of the two types of child assessment is different (Ten Eycke & Dewey, 2016; Toplak et al., 2013). The Childhood Executive

Functioning Inventory (CHEXI; Thorell & Nyberg, 2008) is a free-to-download questionnaire that predicts academic challenges due to executive function difficulties.

Executive Functions and Academic Achievement

Some meta-analytic studies have also reported a moderate association between executive functions and academic achievement (e.g. Pascual et al., 2019). This association between executive functions and early school readiness factors supports enhancing those skills to improve school performance, especially for children from different SES backgrounds (Sasser et al., 2017). For example, when one solution is not working during learning, cognitive flexibility allows one to change or shift to another 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, to keep the 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 studies have reported that working memory contributes to reading and mathematics across age groups (e.g., Christopher et al., 2012), others have identified inhibition (e.g., Vandenbroucke et al., 2017), and others reported that both inhibition and working memory do not significantly contribute to academic achievement (e.g., Lee et al., 2012). These contradicting results call for more studies using different children's ages, sample sizes, assessment methods and data analysis (Jacob & Parkinson, 2015). However, most of these assessments were done in the West and adopted laboratory-based assessments (Nakamichi et al., 2021).

Elementary Education in Kenya

Kenya recently changed her curriculum to the Competency-Based Curriculum (CBC), introduced in 2017 to correct the weaknesses of the previous 8-4-4 system that focused too much on content mastery and examinations. According to the CBC curriculum, early years' education starts at four in preprimary I and five in preprimary II. Preprimary assessment is formative and aims to identify the learners' weaknesses and ensure a 100% transition to grade 1. These assessments are based on pre-academic skills in five learning areas: Mathematical activities, Language, Psychomotor, Creative, Environmental and Religious activities (Republic of Kenya, 2017). This assessment is domain-specific, and no domain-general skill such as motivation or executive functions in preprimary II is assessed to support intervention strategies as children transition to grade one. In grades one to three, pupils are assessed in the following activity areas; Kiswahili, Literacy, English, Mathematical, Environmental, Movement, Art and Craft, Music, Hygiene and Nutrition and Religious activities (KICD, 2017). Again no domain-general skills are assessed. Besides the learning areas, CBC focuses on the child's holistic development and integration of other transversal skills such as communication and collaboration, digital literacy, creativity and imagination, citizenship, learning to learn, critical thinking and problem solving (KICD, 2017). Approaches to learning skills, mastery motivation and executive functions are foundational for developing critical thinking, creativity, 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).

Executive function studies in Kenya have received mixed results. The Children's Investment Fund carried out the Tayari program (2014-2018) in Kenya to improve school readiness and transition to grade one. Although school readiness improved by 5.1 index points in grade one, executive function scores were not associated with the Tayari program (Willoughby et al., 2019). In another study, Willoughby et al. (2021) conducted a cluster randomized control trial study employing RedLight/PurpleLight intervention program as a follow-up to their previous school readiness enhancement program. The results showed that there was no significant difference between the post-pre-test results of the experimental and control groups. They associated the null results with measurement and contextual issues. Although there has been some success, some studies have registered mixed results regarding the ecological validity of executive function interventions. First, the studies implemented in Kenya were population-based studies meant to inform the program and policy makers but not individualized intervention. Second, the mode of assessment was laboratory-based measures that target availability of cognitive skills but not application of these skills at home or school. Third, no attention was given to mastery motivation. We are not aware of any study that has assessed the application of these two critical skills of approaches to learning and their association with academic achievement during preschool to grade one transition.

Based on the theory of approaches to learning, both mastery motivation and executive functions are essential components. We, therefore, operationalized approaches to learning to be equivalent to mastery motivation and executive functions for this study. Figure 1 displays the theoretical association of mastery motivation, executive functions and academic achievement in a path diagram. From this model, we developed five hypotheses.

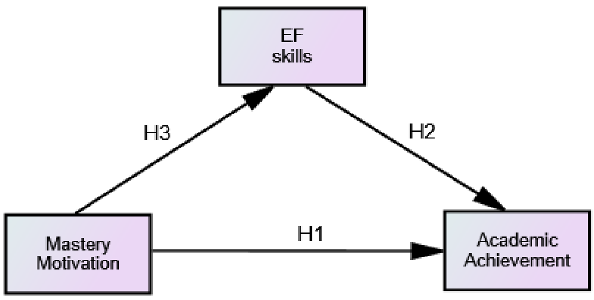

Figure 1
Theoretical model of the relations between mastery motivation, executive function skills and academic performance

Thus, we hypothesized that;

(1) Mastery motivation has positive independent effects on academic achievement (H1).

(2) Executive functions have a direct impact on academic achievement (H2),
(3) Mastery motivation has a direct impact on executive function (H3),
(4) Executive functions mediate the relationship between mastery motivation and academic achievement (H4),
(5) Children with low mastery motivation and high executive function difficulties tend to have low academic achievement (H5).

METHOD

Research Design

The study adopted an associational research design that utilised the quantitative survey methods to collect data to investigate the association between the independent and dependent variables (Gliner et al., 2017). As a result, the study has two independent variables, mastery motivation and executive functions, related to the dependent variable academic achievement in grade one.

Participants

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). Each class selected ten boys and ten girls 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). All of the children were of Kenyan origin and typically normal. Approximately 56% of the parents had secondary education and practised subsistence farming.

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 of schools. In each class, 20 children were selected (10 boys and 10 girls, counterbalancing for gender) using systematic random sampling. We used the class register to obtain the list of all students for that class. We separated the list of boys from girls. For example, if the boys are 30, we divided the number by 10 to get the k^{th} value, after which we would pick the next pupil. For this example, we would select a pupil after every third count on the list. A total of 33 classroom teachers and four research assistants rated the children from their respective classrooms and schools. The direct assessment of academic achievement was administered over three days following a government examination calendar in all the schools.

Measures

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 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 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."

The cognitive scale had excellent internal reliability of 0.821, similar to Amukune et al. (2021). The cognitive persistence scale for mastery motivation denotes the child's motivation to persist and master school-related cognitive tasks (Józsa & Morgan, 2014). It also represents the most robust connection with school achievement (Józsa & Molnár, 2013; Mokrova et al., 2013).

Executive Functions

The Childhood Executive Functioning Inventory (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*. Across the four subscales, factor analysis in children identified two categories: working memory (working memory and planning), with 13 manifest variables. To compute working memory, the following items are added together, items 1, 3, 6, 7, 9, 19, 21, 23, 24, 12, 14, 17 and 20). For inhibition (inhibition and regulation), with 11 variables, the following items are also summed up, items 2, 4, 8, 11, 15, 5, 10, 13, 16, 18 and 22). Finally, total executive functions difficulties in working memory and inhibition are added together. Participants with high scores of executive functions on the CHEXI have high executive function impairment or difficulties (Camerota et al., 2018). The CHEXI has been validated in many cultures, including Kenya (Amukune & Józsa, 2021), and it is found to have good reliability, working memory scale (α = 0.954) and inhibition α = 0.862. Therefore, the CHEXI is a valuable screening tool for predicting academic difficulties (Thorell et al., 2013).

Academic Achievement

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 achievement of grade 1 pupils during the second term. All the 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 Kenya. 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 1 for each correct answer and 0 for each incorrect one. The total marks per subject were converted into a percentage score.

Data Analysis Strategy

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 to construct the latent factors in Amos 24. The model fit indices were RMSEA and SRMR ≤ 0.06, CFI and TLI ≥ 0.90 (Hu & Bentler, 1999). In the second, path analysis in Amos was used to determine the independent direct and indirect effects of mastery motivation and executive functions on academic achievement. During model development, we controlled age, sex, and type of school attended. In the third strategy, a One-Way Analysis of Variance (ANOVA) was used to identify significant differences between children with low mastery motivation and high executive function difficulties and those with high mastery motivation and low executive function 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%.

FINDINGS

Preliminary Analysis

Descriptive statistics that indicate the means, standard deviations and reliability of each scale are shown in Table 1. The age of the grade 1 children ranged from 6 to 13 years. The normative age for a grade 1 pupil in Kenya is between 6 and 7 years (Republic of Kenya, 2017). However, government efforts to encourage children who dropped out to return to school have yielded fruit. As a result, there were no significant differences between pupils aged 6–7 years and those aged eight years and above regarding their academic achievement, t (533) = 1.254, p = 0.21. Moreover, there were no significant differences between boys and girls (58.3%) concerning all predictive variables (all t values (533) < -1.096 p >.273). Nevertheless, there was a significant difference between pupils attending public and private schools on all predictors (All t values (533) < -10.242 $p < .001$). 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 1
Descriptive statistics for the study variables

Variable	Mean	SD	Range	Reliability
Mastery motivation				
Cognitive persistence	3.43	0.78	1-5	.85
Gross motor persistence	3.77	0.70	1-5	.83
Social persistence with adults	3.46	0.78	1-5	.80
Social persistence with children	3.72	0.68	1-5	.86
Total Persistence	3.65	0.61	1-5	.93
Mastery pleasure	3.76	0.69	1-5	.80
Negative reaction	3.42	0.69	1-5	.79
General competence	3.66	0.75	1-5	.81
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	

Bivariate Correlations of the Study Variables

Table 2 displays the bivariate correlations of the study variables. Children with high total executive function difficulties (working memory and inhibition) tended to have low academic achievement scores. There was a moderate correlation between total executive function difficulties with mathematics (r = -.31 p < 0.01), English (r = -.40), and Kiswahili ($r = -.407$, $p < 0.01$). Moreover, those who had high cognitive persistence tended to have high academic achievement ($r = .357$; $p < 0.01$) scores. Similar results were also noted for the type of school the child attended, which positively correlated with academic achievement ($r = .364$; $p < 0.01$). 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. Total persistence was also moderately associated with math, English, and Kiswahili performance.

Table 2
Bivariate correlation of the study variables

	1	2	3	4	5	6	7	8	9	10	11	12
Age	-											
Sex	- 0.069	-										
Sch_Ty	0.002	0.054	-									
Maths	- 0.095*	- 0.004	0.402**	-								
Eng	0.067	0.059	.0352**	0.540**	-							
Kisw	- 0.010	0.058	0.199**	0.493**	0.734**	-						
ACAD	- 0.010	0.047	0.364**	0.767**	0.898**	.888**	-					
COP	0.062	0.018	0.121**	0.238**	0.347**	.320**	0.357**	-				
MP	0.096*	- 0.012	0.223**	0.301**	0.415**	.377**	0.430**	0.547**	-			
Tot_Per	0.077	0.031	0.200**	0.286**	0.410**	.347**	0.410**	0.777**	0.728**	-		
WMEM	-0.154**	- 0.004	-0.249**	-0.277**	-0.410**	-.349**	-0.408**	-0.329**	-0.501**	-0.499**	-	
Inhibition	-0.035	-0.090*	-0.308**	-0.306**	-0.315**	-.254**	-0.339**	-0.309**	-0.377**	-0.422**	0.739**	-
Tot_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, Sch_ty = School Type, Eng = English, Kisw = Kiswahili, Tot_Per = Total Persistent, Tot_ Ef = Total executive functions

Measurement Models

We used CFA to test the measurement models from the CHEXI and to construct the latent factors in Amos 24. We utilized Full Maximum Likelihood when testing the models with no missing values. The two-factor model fitted 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, 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 fitted 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 was expunged from the data.

Principal Analyses

We conducted a series of model tests to evaluate our hypotheses. First, we fitted the mastery motivation and executive function sub-scales into the model fitness tests. However, gross motor, social persistence, negative reactions, and general competence did not produce acceptable model fit indices, so they were dropped from the model. On the other hand, cognitive persistence (COP) and mastery pleasure (MP) sub-scales of mastery motivation produced acceptable model fitness. We, therefore, tested their predictive ability on academic achievement, specifically in Math, English, and the Kiswahili language. We also hypothesized that executive function difficulties would have a detrimental effect on academic achievement. Table 3 shows the model fits of measurement models of executive function difficulties (working memory and inhibition) with COP and MP in separate models and both COP and MP combined in one model.

Effects of Mastery Motivation and Executive Function difficulties on Academic Achievement

Hypothesis I and II sought to determine whether mastery motivation and executive function could predict academic achievement. Figure 2 presents the results of the path model predicting academic achievement in grade 1 from mastery motivation (Cognitive Persistence (COP) and Mastery Pleasure (MP)), controlling for age, type of school the child attended and child's gender. The model fitted well with the data. Fit indices $\chi 2$ =1614.906, $p < .001$, df = 601.00 CFI = .910, RMSEA = .056 (90% CI: .053, .060), SRMR = .04, TLI = .900

Math

In the first model of COP, executive functions and math achievement fitted the data well; COP (β = .42, $p < .001$), inhibition ($\beta = -.11$, $p < .001$), and working memory difficulties ($\beta = -.77$, $p < .001$) significantly predicted mathematics achievement (Table 3A). In the second model, we replaced COP with MP; inhibition ($\beta = -.62$, $p < .001$) and working memory ($\beta = -.13$, $p < .001$) were significant negative predictors, and MP (β = .65, $p < .001$) was a positive predictor (Table 3B). Finally, in the third model, both COP and MP were fitted using the same model. Inhibition ($\beta = -.40$, $p < .001$) and working memory ($\beta = -.49$, $p < .001$) difficulties were significant negative predictors, and MP (β = .80, $p < .001$) significantly predicted mathematics achievement (Table 3C). However, COP did not significantly predict mathematics achievement in this model. Thus, an increase in 1SD COP contributes to an increase of 0.42 SD in academic achievement in model 1. In addition, an increase in 1 SD MP lead contributes to an increase of 0.65 SD in academic achievement in model 2. Nevertheless, 1 SD working memory difficulties increase, reducing academic achievement by 0.77 SD in model 1 and 0.13 SD in model 2.

English

For English, the trend was the same. In the first model, with COP and executive functions, inhibition ($\beta = -.61$, $p < .001$) and working memory ($\beta = -.09$, $p < .001$) were negative predictors, while COP (β = .60, $p < .001$) was a positive predictor (Table 3A). In the MP model, working memory ($\beta = -.08$, $p < .001$), inhibition ($\beta = -.41$, $p < .001$), and MP (β = .79, $p < .001$) were significant predictors (Table 3B). When COP and MP were introduced into the same model, MP was a significant predictor of English achievement (β = .83, $p < .001$(Table 3C), while COP was not. Furthermore, inhibitory difficulties ($\beta = -.40$, $p < .001$) and working memory difficulties ($\beta = -.08$, $p < .001$) were significant negative predictors.

Kiswahili

For Kiswahili, working memory ($\beta = -.90$, $p < .001$), inhibition ($\beta = -.05$, $p < .001$), and COP (β = .09, p < .001) were significant predictors in the COP model (Table 3A). In the MP model, inhibition ($\beta = -.33$, $p < .001$), working memory ($\beta = -08$, $p < .001$), and MP (β = .85, $p < .001$) were also significant predictors (Table 3B). When COP and MP were combined into one model, MP ($\beta = -.74$, $p < .001$) was a positive predictor for

Kiswahili, but COP (β = .07, p < .001) was a weak predictor, and EF skills were insignificant (Table 3C). 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.

In summary, for hypotheses I and II, both COP and MP positively predict academic achievement separately in models 1 and 2. However, when COP and MP were placed into one model, MP became more dominant, and the effects of COP were diminished: MP became a more robust indicator, and COP became a weaker indicator. Regarding executive function difficulties, Inhibition and working memory were significant but negative predictors of academic achievement in both models (Fig. 2).

Table 3
Model fits of the measurement models

3(A) Working Memory, Inhibition and Cognitive persistence (Model 1)

Model	χ^2	*Df*	RMSEA		CFI	TLI	SRMR
Maths	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

3(B) Working memory, Inhibition and Mastery pleasure (model 2)

Model	χ^2	*Df*	RMSEA		CFI	TLI	SRMR
Maths	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

3© Working Memory, Inhibition, Cognitive persistence and Mastery pleasure combined (model 3)

Model	χ^2	*Df*	RMSEA	CI	CFI	TLI	SRMR
Maths	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

Hypothesis III tested whether there was a direct effect of mastery motivation on executive functions. COP, with six items, and MP, with five items, was derived from the mastery motivation scale, while inhibition, with 11 items, and working memory, with 13 items, came from the executive functions scale. The results indicate that executive function difficulties had a significant but negative (inverse) direct effect on mastery motivation, such that the more significant the executive function difficulties, the lower the mastery motivation and vice versa (Fig. 2).

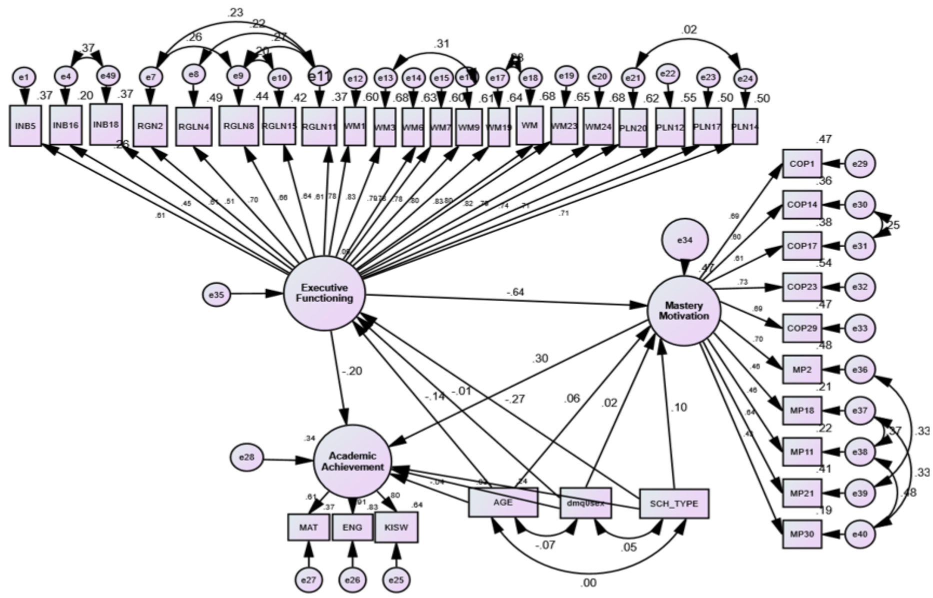

Figure 2
Direct and indirect effect of mastery motivation executive function difficulties on academic performance

Note. Path model predicting academic performance in grade 1 from mastery motivation (COP - cognitive persistence and MP- 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 $\chi2$ =1614.906, Df = 601.00 CFI = .910, RMSEA = .056 (90% CI: .053, .060), SRMR = .04, TLI = .900

Hypothesis IV tested the moderating effect of mastery motivation through executive functions. The indirect relationship between mastery motivation and academic achievement as mediated via executive functions difficulties was significant (indirect effect: $\beta = .061$, $p < .001$), with a significant total effect ($\beta = -.297$, $p < .001$). For an effective increase in academic achievement, executive function difficulties should be reduced to a minimum. The mediating measurement model through executive functions skills indicated an acceptable fit: $\chi2$ (708) = 1833.66, p < 0.001, $\chi2$/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 executive functions skills and academic achievement variance, respectively. However, executive function skills had no indirect effect on academic achievement through mastery motivation.

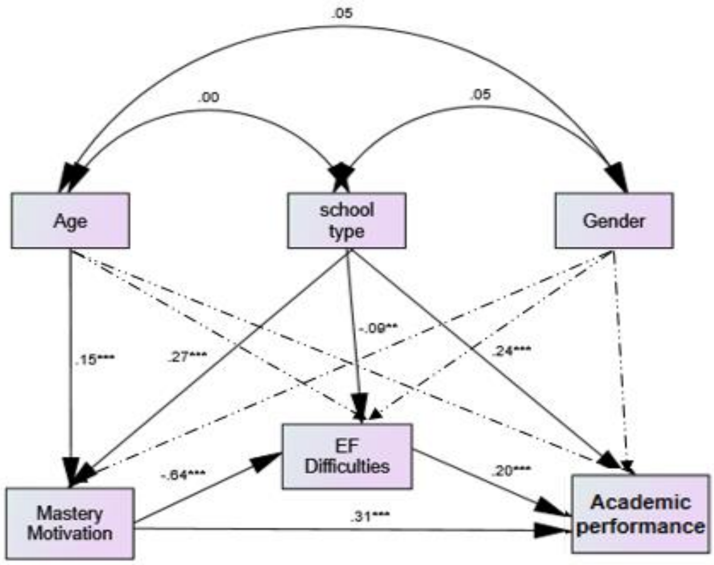

Figure 3
Mediation model of the relations between mastery motivation, executive function skills and academic achievement

Note. Simplified path model predicting academic achievement 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 $\chi 2$ =1833.66, df = 708.00 CFI = .904, RMSEA = .055 (90% CI: .052, .058), SRMR = .04,

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. Group (1) low mastery motivation and high executive functions difficulty (worst needs intervention), (2) low mastery motivation and low executive functions difficulty, (3) high mastery motivation and high executive functions difficulty, and (4) high mastery motivation and low executive functions difficulty. We used one-way ANOVA to determine whether the four groups significantly differed in academic achievement. Results showed a significant difference in mastery motivation and executive functions difficulty in math [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 achievement [F (3,237) = 40.054, $p < .001$] for the four groups. The post hoc comparisons showed that the mean score for low mastery motivation/high executive functions difficulty (M = 49.33, SD = 14.10) was significantly different from that for high mastery motivation/low executive functions difficulty (M = 74.74, SD = 16.09). Taken together, the pupils that had high mastery motivation/low executive functions difficulty (best) (n = 95) and those that had a low mastery motivation/high executive functions difficulty (worst) (*n* = 73) in academic achievement showed a 25.41% *points* difference, in math, 15.39% *points*; in English, 28.54% *points*; and in Kiswahili, 28.62% *points*. The eta effect sizes ranged from 0.18 to 0.34, signifying moderate to large eta effect sizes (Table 4).

Table 4
Means, Standard Deviations and One Way Analysis of Variance of academic achievement and Mastery motivation and executive function difficulties

Measure	Mastery Motivation and Executive Functions difficulties								F ratio (2, 237)	η^2
	Low-mastery motivation, High-EFdiff		High-mastery motivation, High-EFdiff		Low-mastery motivation, Low-EFdiff		High-mastery motivation, Low-EFdiff			
	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; EFdiff = Total Executive Function Difficulties; Eng =English; Kisw = Kiswahili ***$p < .001$

DISCUSSION

The study's main aim was to determine mastery motivation and executive functions' direct and indirect contribution to academic achievement. Mastery motivation subscales cognitive persistence and mastery pleasure were moderately associated with academic achievement. This result is congruent with Józsa and Molnár (2013) and Józsa and Barrett (2018), who also reported that cognitive persistence and mastery pleasure had the most robust connection with academic performance. Other studies involving low-risk children (e.g., Mercader et al., 2017) and high risk also found a significant association between mastery motivation and academic achievement. Ramakrishnan and Masten (2020) also reported that mastery motivation was associated with mathematics skills among children experiencing homelessness, although the correlation vanished when age and intelligence were controlled. However, in the present study, mastery pleasure was more associated with academic achievement. We also tested whether mastery motivation could predict the academic achievement of grade 1 learners. The cognitive persistence and mastery pleasure scales of mastery motivation generally predicted Math, English, and Kiswahili performance significantly. Again, beyond our expectation, when both cognitive persistence and mastery pleasure were placed in one model, mastery pleasure became a better predictor than cognitive persistence. Other studies have reported that cognitive persistence is a better predictor than mastery pleasure (e.g., Mokrova et al. 2013), although these studies predicted grade eight GPA based on grade four school-related skills and math.

Executive function difficulties were negatively associated with academic achievement, similar to Thorell et al. (2013). This result suggests that high executive function difficulties correlate with low academic achievement. Similarly, executive function difficulties predicted math and English language negatively. We compared the association of Math, English, and Kiswahili with executive function difficulties. We found that Math had a lower negative association with executive function difficulties, indicating that it is more strongly associated with executive functions than English or Kiswahili. Similar associations were also reported by 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 due to its utilization at home and school among most pupils.

Few studies have examined the impacts of mastery motivation on executive function skills. One possible reason for this could be that most of the studies on executive functions have utilized performance-based measures that directly measure the underlying cognitive skills instead of behavioural measures that focus on applying those skills either at home or at school (Camerota et al., 2018; Toplak et al., 2013). In addition, studies that have combined motivation and executive functions are rare. In the present study, students with high mastery motivation had lower executive function difficulties and vice versa. The path from mastery motivation to executive function difficulties was negative but significant, indicating that high mastery motivation lowered executive function difficulties. However, the opposite was not significant. This outcome suggests that strategies that improve mastery motivation have the potential to lower executive function impairments. Some authors have reported that children must keep their goals in mind when solving challenging tasks, significantly improving executive functions (Hauser-Cram et al., 2014). Nevertheless, some studies have found no association between mastery motivation and executive functions (e.g., Ramakrishnan & Masten, 2020) in at-risk children. Ramakrishnan and colleagues associated this situation with this sample’s homelessness, increasing their behavioural challenges and lower academic performance compared to impoverished children with stable homes. Higher executive function 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 executive function skills have a higher chance of having problems like physical aggression, impulsivity, lack of concentration, and challenges in controlling their emotions in the classroom (Jahromi & Stifter, 2008; Maksum et al., 2021).

Recently, authors have pointed out that approaches to learning can mediate the effects of executive function difficulties on children’s academic achievement in learning and adaptive classroom behaviours (Nesbitt et al., 2015; Sasser et al., 2017). However, no indirect effects of executive functions on academic achievement through mastery motivation were identified in this study. Our results were also congruent with this outcome. We tested whether there was an indirect relationship between mastery motivation and academic achievement via executive function difficulties. This path was significant with an acceptable model fit indicating that if executive function difficulties are reduced to a minimum, this path can significantly contribute to academic achievement. However, the path of executive function through mastery motivation was insignificant.

Children with high mastery motivation and low executive function difficulties had higher average scores than those with low mastery motivation and high executive function difficulties. This suggests that intervention strategies to help improve mastery motivation and executive function difficulties can help close the gap between best and worst performance in academic achievement. It has been reported that children from low SES face more significant academic difficulties than their peers (e.g., Fitzpatrick et al., 2014). Some studies have indicated that SES and cognitive ability each uniquely account for 15% of the variance in academic performance (e.g. Demetriou et al., 2019). This study also indicates that students 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). Therefore, 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). Furthermore, mastery motivation contributes significantly to resilience and school readiness domains, especially for at-risk children (Ramakrishnan & Masten, 2020).

This study has some implications for practice. Since Kiswahili had the lowest cognitive load, some studies have also advocated using the Swahili language and other local vernaculars in teaching and learning in the elementary grades (e.g., Mose, 2015). In addition, interventions that enhance executive functions and mastery motivation can significantly improve children's approaches to learning. This will, in turn, improve academic performance. Such interventions that support children's learning include whole-brain teaching (Elfiky, 2022; Emyus et al., 2020). This is an adaptive instructional strategy with seven steps to improve the development of the learner's attention, motivation, emotions, and self-regulation. Further, quality math teaching has a spillover effect on executive function enhancement. Curriculum such as Montessori has been found to impact math competence and executive function development (Mulcahy et al., 2021). Other studies have shown that executive functions can be improved by adjusting children's everyday experiences at home and school after identifying a child's emerging abilities. Such experiences include practising daily routines, games and play, martial arts, and quality math teaching interventions (Blair, 2017; Howard & Melhuish, 2017). To enhance mastery motivation, 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. Besides improving mastery motivation, such strategies improve executive functions, language, and cognitive development (Mermelshtine, 2017).

LIMITATIONS

Albeit the standardized achievement tests meet international standards, intensely reliable and validated tools, the present study had some limitations. First, it is unclear how adult rating accurately reflects the child's abilities. Characteristics of the teacher, such as implicit bias, memory error and confounding competence with motivation, are some of the challenges that reduce the validity of adult ratings as measures of the actual behaviour of the child (Józsa & Molnár, 2013; Sasser et al., 2015). Second, parents could also be involved as an alternative source of information to complement the ratings from teachers. However, some studies have reported no significant difference between teachers and parents in the ratings of children (Camerota et al., 2018). Future studies can combine teachers and parents to provide data via ratings and include laboratory measures for direct assessments in a longitudinal study. Computer-based assessments for mastery motivation and executive functions for Kenya are now available (e.g. Amukune et al., in press). Additional measures for approaches to learning, such as Preschool Learning Behaviors Scale (PLBS; McDermott et al., 2002), can also be combined with other direct measures to provide a diversity of options to parents and other stakeholders when making decisions concerning children.

CONCLUSION

The results of the current study revealed that mastery motivation subscales, cognitive persistence and mastery pleasure were moderately associated with academic achievement. In addition, cognitive persistence and mastery pleasure subscales contribute to academic achievement, although mastery pleasure was a better predictor. On the other hand, executive function difficulties had a negative association with academic achievement. Further, high mastery motivation was associated with low executive function difficulties. In addition, mastery motivation was indirectly related to academic achievement through executive function difficulties. Thus, if executive function difficulties are reduced, this path can be strengthened to enhance academic achievement. Taken together, children with low mastery motivation and high executive function difficulties significantly differed from those with high mastery motivation and low executive function difficulties. Therefore, intervention strategies for mastery motivation and executive functions can benefit children with low academic achievement. Focusing on domain-specific curriculum intervention alone during instruction is not enough to enhance academic achievement and life success. Since mastery motivation and executive functions are malleable, selective intervention strategies that focus on the home and school can be adopted, especially among children with low mastery motivation and high executive function difficulties.

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