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Executive Functions, Motivation, and Children's Academic Development in Côte d'Ivoire

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The role of executive function skills and motivation in supporting children's academic achievement is well-documented, but the vast majority of evidence is from high-income countries. Classrooms in sub-Saharan Africa tend to be large, teacher-driven, and lecture-focused, which may provide extra challenges for children to stay engaged in the learning process. Based in self-regulated learning theory, we tested the contributions of executive functions and motivation for children's literacy and numeracy skills over 1 school year. Our preregistered study of 2,500 primary school students in Côte d'Ivoire used lagged models with a robust set of demographic covariates. Executive functions were directly assessed, and children reported on their levels of motivation for schooling. Findings indicated strong longitudinal continuity of both literacy and numeracy skills over the academic year. Further, we found unique associations of executive functions and intrinsic motivation with changes in children's literacy skills and a unique association of executive functions, but not intrinsic motivation, with changes in children's numeracy skills over the school year. Overall, these results provide evidence for the importance of nonacademic skills for children's learning in a rural, sub-Saharan African context. Implications include improving access to preprimary education, the quality of primary school experiences, and teacher training and supports to increase children's early academic skills, self-regulation skills, and motivation for learning.

Keywords: executive function, motivation, sub-Saharan Africa, self-regulated learning, academic achievement

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Nonacademic skills such as self-regulation, persistence, and motivation, are important for children's classroom learning and academic achievement. Self-regulated learning theory emphasizes that children need both the ability and the motivation to engage in learning (Garner, 2009; Knouse et al., 2014; Zimmerman, 1990). Executive functions (EFs) are under the broad umbrella of self-regulation skills and allow children to regulate their attention and behaviors (Diamond, 2013). EFs are implicated in the direct acquisition of math and reading skills (Cartwright, 2012; Kroesbergen et al., 2009) and also support children's learning-related behaviors in the classroom (Nelson et al., 2017). Separately, prior research in high-income countries has shown that aspects of children's motivation uniquely contribute to adaptive classroom behaviors and achievement, over and above EFs (Finch & Obradović, 2017; Howse et al., 2003; Sulik et al., 2020).

The vast majority of studies examining the role of nonacademic skills for children's learning have been conducted in high-income countries. Whether these skills have the same importance across diverse contexts, including classrooms in sub-Saharan Africa where learning levels are generally low, is not known, though a few studies suggest they may be important aspects of children's learning in other low-income country contexts (Chiu & Xihua, 2008; McCoy et al., 2014; von Suchodoletz et al., 2015; Wolf & McCoy, 2019b). The current study examines the unique contributions of EFs and motivation skills for children's academic achievement in a sample of primary school students from two rural cocoa-growing regions in Côte d'Ivoire.

Self-Regulated Learning: The Intersection Between EFs and Motivation for Children's School Success

Self-regulated learning theory emphasizes the active role of students in their learning through their efforts to control their own cognition, motivation, and behavior (Pintrich, 2000; Schunk & Zimmerman, 2012; Zimmerman, 2008). This theory highlights that learning requires both the ability to engage with learning material and the will to do so (Hofmann et al., 2012; Wolters, 2003). Thus, there are additive

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This study's design, hypotheses, and analysis plan were preregistered. Additionally, all data, analysis code, and research materials are available. See the following website for this information: https://osf.io/y9emz/.
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benefits of the self-regulation skills necessary for learning (i.e., children's EFs) and children's motivation to engage in learning. A longstanding body of research has linked self-regulated learning to academic success for children in primary school classrooms in high-income countries (Dignath & Büttner, 2008; Zimmerman, 1990). Recent evidence suggests that self-regulated learning may also be an important predictor of achievement in Western China. In a sample of fourth and fifth grade students, a composite measure of responsible decision making, social awareness, self-management, and relationships skills was associated with reading, math, and science achievement (Wang et al., 2019).

Sociocultural theory highlights that children's learning is shaped by expectations and interactions that occur within different societal contexts (Vygotsky, 1978). Cultures in different regions of the world emphasize varying competencies as important for success in school and community life (e.g., Henrich et al., 2010; Serpell, 2011). For example, there are large contrasts between Western and non-Western populations on social decision making (cooperation, fairness) and the value of interdependence (Henrich et al., 2010; Jukes et al., 2021). Research in sub-Saharan Africa specifically demonstrates that social responsibility is considered an aspect of "intelligence" in these communities, and has implications for children's behaviors in classroom contexts (Serpell, 2011). It is plausible that the role of self-regulated learning for children's academic achievement may differ in rural sub-Saharan African contexts, where values of obedience, respect, and responsibility are emphasized by both parents and teachers (Jukes et al., 2021).

Executive Functions and Learning

Executive functions (EFs) are a set of higher-order cognitive skills that allow children to regulate their attention and behavior (Diamond, 2013). There is strong evidence in high-income countries of the role of EFs for academic achievement via two pathways. First, EFs are linked to the direct acquisition of mathematics and reading skills (Cartwright, 2012; Kroesbergen et al., 2009). Second, EFs contribute to adaptive classroom behaviors that support learning, such as staying on task, perseverance, and managing assignments (Finch & Obradović, 2017; Nelson et al., 2017). There is some recent evidence from sub-Saharan Africa that EFs are linked to children's academic outcomes in preschool and early primary school. A cross-sectional study of preschoolers in Kenya demonstrated that a battery of EF tasks was associated with both preliteracy and prenumeracy skills in children (Willoughby et al., 2019). Another study in Kenya found correlations between teacher-rated EFs and a composite measure of children's mathematics, reading, and writing achievement (Amukune & Józsa, 2021). Finally, Ghanaian children's EFs were associated with growth in both literacy and numeracy skills in the first 2 years of primary school, after controlling for children's social-emotional skills such as emotion identification and peer social skills (Wolf & McCoy, 2019b). Together, these studies indicate that EFs may be consequential for early literacy and mathematics achievement for young children in sub-Saharan African countries, and support claims that EFs might be universal skills associated with learning (Obradović & Willoughby, 2019).

Motivation for Learning

A separate literature has emphasized the role of motivation for learning. Motivation provides the will to initiate and sustain goal-directed activities (Schunk & Zimmerman, 2012) and is necessary for cognitive engagement in the classroom (McLaughlin et al., 2005). In high-income countries, children with higher motivation are more likely to demonstrate academic success as indexed by achievement test scores and school grades (Corpus & Wormington, 2014; Taylor et al., 2014). In a sample of adolescents across 41 countries, including low-income and middle-income countries, students' motivation was consistently associated with higher mathematics achievement (Chiu & Xihua, 2008). Evidence from Nigerian and Kenyan secondary schools show that cooperative learning environments, which are more likely to promote student motivation, are linked to higher mathematics and science achievement than competitive learning environments (Kolawole, 2008; Wachanga & Mwangi, 2004).

Unique Contributions of EFs and Motivation

Based on self-regulated learning theory, EFs and motivation are likely to have additive contributions to children's school achievement. EFs would support children's abilities to focus in the classroom, manage assignments, and track their learning. In contrast, children's motivation would provide them with the will to engage in these adaptive classroom behaviors. However, the two are rarely studied together empirically. A handful of studies do lend support to the unique contributions of EFs and motivation for children's academic success in the Unites States. For example, in a small sample of kindergarteners, both teacher report of students' motivation and directly-assessed EFs were associated with children's reading scores (Howse et al., 2003). Further, in a racially and socioeconomically diverse sample of elementary school students, EFs and an aspect of motivation—challenge preference—were uniquely associated with children's adaptive classroom behaviors and academic achievement (Finch & Obradović, 2017; Sulik et al., 2020).

These issues have not yet been studied in a sub-Saharan African context, where classrooms are structured differently than in the United States, with teacher-driven and whole-group instruction being the norm (Lerkkanen et al., 2016). While some evidence has established that EFs are related to young children's learning in sub-Saharan African contexts (e.g., Willoughby et al., 2019; Wolf & McCoy, 2019b), the interplay between EFs and motivation during primary school is unknown. Despite increasing school enrollment, learning levels are considerably low in West Africa, and Côte d'Ivoire specifically (Angrist et al., 2021). While there are several sources of low learning levels, some have pointed to the reality that instruction in many classrooms in the region is primarily teacher-directed and that student engagement and participation is low (Perry et al., 2002; Tabulawa, 2013). Given this, children's abilities to self-regulate and their motivation to do so may be particularly important for their learning in such classrooms.

Primary School Education in Sub-Saharan Africa

While enrollment in primary school has increased dramatically in sub-Saharan Africa, support for teachers, classroom quality, and learning levels are all very low (Angrist et al., 2021; Bashir et al., 2018). Classrooms face significant resource constraints: only a third of classrooms in sub-Saharan Africa have electricity, a fifth have access to toilets, and two to three students commonly share one textbook (Mbiti, 2016). Typically, classrooms are much larger compared to high-income countries and rates of teacher absences are high (UNESCO, 2012). Classrooms tend to be lecture-driven, rigid, and teacher-dominated with few opportunities for students to actively engage with learning material. When not lecturing, teachers tend to ask a series of preplanned questions and rarely interact with the substance of students' responses (Metto & Makewa, 2014). Moreover, efforts to improve children's access to school, such as reducing school fees, may not remove barriers to student attendance. Primary and junior high school students in Ghana reported missing school at the highest rates due to personal illness and work-related reasons (Wolf et al., 2016), suggesting that efforts to increase attendance and associated learning need to involve coordination with parents and communities.

Given these structural and pedagogical barriers, most students who attend primary school in sub-Saharan Africa do not acquire basic academic skills. In 2017, representative surveys from seven sub-Saharan African countries, representing close to 40% of the region's total population, found that three-quarters of second graders could not count beyond 80, and 40% could not do a one-digit addition problem (Bold et al., 2017). Further, primary school attendance is not even supporting basic literacy skills for children—in fourth grade, 40% of children could not read a single letter, 70% could not read a single word, and 90% could not read a paragraph (Bold et al., 2017).

The educational picture in Côte d'Ivoire is representative of sub-Saharan Africa. The government has been successful at increasing enrollment at the primary school level over the past 10 years (UNESCO, 2019). However, while Côte d'Ivoire's government spends more than other countries in the region on education (UNESCO, 2019), very few students demonstrate minimum learning achievement. The most recent PASEC data, which focuses on Francophone countries in West Africa, rates Côte d'Ivoire among the bottom 30 countries globally (Angrist et al., 2021), with large inequalities between urban and rural regions (PASEC, 2020). Even among children attending primary school, the average fifth grader can only read a few words (Jasińska et al., 2018). This is partly due to structural barriers leading to high rates of teacher absences, and in rural areas, very large class sizes and little ongoing professional development and training for teachers (World Bank, 2017). Further, both Ivorian civil wars (in 2002 and 2011) significantly impacted children's education in lasting ways, with both the destruction of school infrastructure and long periods of children being out of school. Estimates suggest that, on average, children in school during the civil wars had almost 1 year of schooling loss (Dabalen & Paul, 2014).

Disadvantaged Subgroups of Children in Sub-Saharan Africa

There are specific groups of children who are particularly marginalized in sub-Saharan Africa and show the lowest rates of school attendance and achievement. Child gender is a key determinant for schooling outcomes in sub-Saharan Africa, with girls being disadvantaged (Evans et al., 2021). Parent engagement may vary by child gender due to greater opportunity costs of schooling for girls (e.g., larger involvement of girls in household or care work), lower perceived returns to girls' education, and widespread gender bias in social norms and aspirations (Alderman & King, 1998; Wolf et al., 2016). Current school enrollment rates in Côte d'Ivoire are 86.0%, with disparities between males and females at 89.8 and 82.1%, respectively (UNESCO Institute for Statistics, 2018). Further, intergenerational educational transmission is particularly salient in sub-Saharan Africa (Azomahou & Yitbarek, 2016; Pufall et al., 2016), such that children whose parents have low levels of educational attainment tend to have lower educational attainment themselves.

For marginalized children, EFs and motivation may be more strongly linked to their academic achievement, based on studies demonstrating self-regulation skills as protective factors for disadvantaged students in the United States (Haslam et al., 2019; King & Mrug, 2018; Liew et al., 2010; Obradović, 2010). For example, using a nationally-representative sample of American kindergarteners, Liu (2019) found that a composite measure of self-regulation, persistence, interpersonal skills, and motivation served as a protective factor for the academic achievement of children from low-socioeconomic status homes. In contrast, research on students from the United States demonstrated that the positive association between motivation and reading achievement was significant for gifted readers but nonsignificant for poor readers (McGeown et al., 2012). This suggests that the benefits of motivation for achievement might actually be limited to more advantaged students. However, these questions have not been explored in sub-Saharan Africa where children's school experiences differ greatly and where children from marginalized groups may not have the same access to schooling as their peers from more advantaged backgrounds.

Current Study

This preregistered study investigates whether EFs and motivation uniquely contribute to growth in literacy and mathematics skills for primary school students in Côte d'Ivoire. The participants are in second and fourth grade, which mark an important transitional period into middle childhood where children are increasingly expected to self-regulate their behaviors and monitor their own progress and behaviors (Felton & Akos, 2011). Children's EFs are directly assessed using two widely used tasks, children report on their own intrinsic and extrinsic motivation, and academic achievement is measured using standardized tasks adapted to capture children's literacy and numerical skills in the region. Based on previous empirical and theoretical evidence (Hofmann et al., 2012; Sulik et al., 2020; Wolters, 2003), we hypothesized that there would be unique benefits of both EFs and motivation for children's literacy and numeracy achievement in the spring, after controlling for lagged measures of achievement in the fall. Finally, we ran exploratory analyses to test whether the links between EFs, motivation, and academic achievement differ by gender and by parental educational attainment.

Method

Participants and Procedure

We preregistered our hypotheses and statistical analyses at the Open Science framework (https://osf.io/y9emz/). Data for this study come from the Eduq+ intervention study conducted in 100 schools in the Aboisso and Bouaflé regions of Côte d'Ivoire. This school-randomized control trial examined impacts of a text message-based intervention to parents and teachers related to educational engagement and improvement. A list of all the schools in the two regions was obtained from the regional education offices. Fifty public schools within each region (N = 385 total in Aboisso, 612 in Bouaflé) were selected by the district education office to participate in the study. Schools were randomly assigned to receive the Eduq+ text message intervention administered: parents only (N = 24 schools), teachers only (N = 25 schools), parents and teachers (N = 26 schools), or a control group (N = 25 schools). See Wolf and Lichand (2022) for more details on the intervention. Data was collected over 1 school year in the fall (October–November 2018; start of the school year) and the spring (May 2019; end of the school year).

In each school, the class rosters of CP2 (cours préparatoires 2, equivalent to second grade) and CE2 (cours élémentaires 2, equivalent to fourth grade) were obtained. Twenty-five children whose parents/guardians consented to their participation in the study were selected per school to participate in the assessments: 13 children were randomly chosen from the CP2 roster, and 12 children randomly chosen from the CE2 roster and data collected in the schools in the fall (beginning) and spring (end) of the school year. Therefore, the study sample is representative of students in the study regions whose parents/guardians consented to their participation. In total, data was collected on 2,475 children at baseline. In the spring, achievement data was collected on 2,246 (89.8%) of those children and an additional 229 children. The study "Harnessing differences to optimize learning: Building on a text-message support intervention to assess individual-level characteristics to promote learning in Côte d'Ivoire" was approved by the Ethics Committee at the University of Zurich (OEC IRB #2018-035).

Transparency and Openness

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study, and we follow Journal Article Reporting Standards (JARS; Appelbaum et al., 2018). All data, analysis code, and research materials are available at https://osf.io/y9emz/. These materials and documentation allow for independent replication of the results presented in this paper. Data were cleaned using Stata, Version 17.0 (StataCorp, 2017) and analyses were conducted using Mplus, Version 8.6 (Muthén & Muthén, 2021). This study's design and its analyses were preregistered at the Open Science Framework and can be accessed at this link: https://osf.io/y9emz/). Our small deviations from the preregistered analyses are specified below in the Analytic Plan.

Measures

All items were translated from English to French and back-translated to English. Assessments were then piloted with 40 children to ensure their suitability for use in this context. Only items that were deemed appropriate after consultation with a local child development expert, were included in the assessment.

Literacy

Literacy in French was assessed using eight tasks measuring preliteracy and literacy domains from two sources. Using the Early grade Reading Assessment (RTI International, 2009b), domains included letter–sound identification, nonword decoding, and word reading. Four additional adapted subtasks from EGRA were used and included phonological awareness, phoneme segmentation, synonyms and antonyms (Jasińska et al., 2018). Finally, one additional measure of phonological awareness from the International Development and Early Learning Assessment (IDELA; Pisani et al., 2018) was also included. The percent correct for each domain was computed, and the score for each domain averaged to create a total score (α = .85).

Numeracy

Numeracy was assessed using eight subdomain tasks. Four tasks from the Early Grade Math Assessment (RTI International, 2009a) included number identification, quantity discrimination, addition, subtraction, and missing number pattern identification. In addition, four tasks from the IDELA (Pisani et al., 2018) were used, which included number knowledge, one-to-one correspondence, shape identification, and sorting abilities based on color and shape. The percent correct for each domain was computed, and the score for each domain averaged to create a total score (α = .86).

Executive Functions

Children's executive functions were measured using two tasks: Hearts & Flowers (Davidson et al., 2006) and the Forward Digit Span (Carlson, 2005).

Hearts & Flowers. The Hearts & Flowers task is a measure of inhibitory control and cognitive flexibility. When children viewed a "heart" or congruent trial, they were told to press the button on the same side as the heart on a tablet computer. When children viewed "flower" or incongruent trials, they were told to press the button on the opposite side of the flower. After practice trials, children completed 11 mixed "heart and flower" trials. We created a composite measure of inhibitory control and cognitive flexibility using the percent of correct responses on the mixed block, where children are asked to sort both hearts and flowers (α = .81).

Forward Digit Span. The Forward Digit Span task was used to measure children's working memory, since the Backward Digit Span task was deemed too challenging for this population during a pilot study in the Aboisso region of 40 schoolchildren in Grades 2 and 4 in a school that was not part of the study sample. Forward span tasks have also been used in studies of young children in Ghana and Pakistan (Obradović et al., 2019; Wolf et al., 2019) to measure working memory when children were unable to complete backward span tasks. Children were visually shown 13 sets of numbers ranging from two to seven digits and asked to write down the numbers they saw in the same order after each set was presented (α = .79). We created a composite measure of working memory using the total span, which is measured by the longest span for which at least two test trials were repeated correctly, plus .5 if one longer sequence was correctly repeated at the next level (Noël, 2009).

Motivation

Children's motivation was measured using nine items from the Elementary School Motivation Scale (Guay et al., 2005). Items focused on children's motivation for schooling and answered on a 5-point scale with 1 = *always no* and 5 = *always yes*. Items included intrinsic motivation (e.g., "I like going to school") and extrinsic motivation (e.g., "I go to school to please my parents or teacher.")

We used exploratory factor analysis and confirmatory factor analysis to test the adequacy of a two-factor solution of the scale. The exploratory factor analysis results demonstrated that a two-factor solution was significantly better than a one-factor solution ($\chi^2(df = 8)$ = 241.199, $p < .001$), with items 1 through 5 loading on Factor 1 and items 6 through 8 loading on Factor 2 (as indicated by loadings >.40). The follow-up confirmatory factor analysis demonstrated that model fit was excellent ($\chi^2(df = 12)$ = 22.902, p = .029, RMSEA = .019, CFI = .996, TLI = .988) and provided strong support for the two-factor solution. See Table S1 in the online supplemental materials for the factor loadings and item stems. Based on these results and our conceptual understandings of the items, we averaged across items 1 through 5 to create a composite measure of *intrinsic motivation* and across items 6 through 8 to create a composite measure of *extrinsic motivation*.

Covariates

Child age and gender (1 = *male*) were drawn from the baseline survey. In addition, include a dummy indicator for region (0 = Aboisso, 1 = Bouaflé), and a set of two dummy variables for whether children's schools were randomly assigned to one of the treatment conditions (text messages sent to parents or text messages sent to teachers). Parent education and household income were collected via surveys with children's parents. Parents' education was coded as the highest level attended and transformed to represent years of schooling (0 = *no schooling*, 40%; 3 = *some primary school*, 21%; 5 = *completed primary school,* 9%; 7 = *some lower secondary school*, 9%; 9 = *completed lower secondary*, 5%; 10 = *some upper secondary school*, 4%; 12 = *completed upper secondary school*, 1%; 13 = *some bachelor's degree course work,* 2%, 14 = *bachelor's degree*, 2%; 15 = *some postgraduate course work*, 2%; and 16 = *postgraduate degree*, 2%). Parents reported their monthly income in CFA (Communauté Financière Africaine) francs. The midpoint of each income category was used, ranging from 5,000 CFA francs/month (equivalent to \$9 USD) to 350,0000 CFA francs/month (equivalent to \$634 USD). Finally, we used lagged measures of literacy and numeracy in the model drawn from the fall semester of school.

Analytic Plan

Analyses were conducted using Mplus, Version 7.3 (Muthén & Muthén, 2021). To account for missing data, we used full information maximum likelihood estimation (FIML). FIML is a model based approach that estimates parameters and standard errors from the observed data of each individual case (Nicholson et al., 2017) and only drops cases when information is missing on all data points (there were no such cases in the current study). FIML is less biased and more reliable compared with listwise or pairwise deletion (Enders & Bandalos, 2001) and commonly employed in path analyses (Nicholson et al., 2017). Model fit was evaluated using the Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and the chi-square test. Values above .95 indicate excellent fit for the CFI and TLI. The cut-offs of .01, .05, and .08 have been used to indicate excellent, good, and mediocre fit, respectively, using the RMSEA (MacCallum et al., 2002).

The main model utilized path analyses with observed variables for Digit Span, Hearts & Flowers, intrinsic motivation, and extrinsic motivation measured in the fall as predictors and literacy and numeracy in the spring as outcomes. Originally, in our preregistered analyses, we had planned to utilize reflexive latent variables for EFs and motivation. However, after reviewing recent evidence that reflexive latent variables can cause biased and variable parameter estimates when not correctly specified and that reflexive latent variables may not be appropriate for measuring EF ability (Camerota et al., 2020; Rhemtulla et al., 2020), we explored the use of composite variables. Our EF measures are designed to capture different aspects of the overall EF construct (inhibitory control and cognitive flexibility on the Hearts & Flowers task and working memory on the Digit Span task), which causes issues when employing a reflexive latent variable that only utilizes variance shared by the two tasks (Bagozzi, 2007). Similarly, our two motivation variables are believed to reflect related, but different aspects of children's motivation to complete their schooling. The use of a reflexive latent variable can also overestimate pathways in SEM models, which we saw in our original analyses using reflexive latent variables (Rhemtulla et al., 2020; see the online supplemental materials). Together, this information led us to specify the scores on the Digit Span and Hearts & Flowers task as separate, observed variables and specify the intrinsic and extrinsic motivation variables as separate, observed variables in our model.

We had also planned to include a measure of growth mindset to load onto the latent motivation variable. First, we learned that the two open-ended questions had not been administered, and so the score would rely on the three Likert-scale type questions. However, once we analyzed the data, we found that the average scores on the three growth mindset questions had a very low correlation with intrinsic motivation (r = .045, p = .023) and was uncorrelated with extrinsic motivation (r = −.018, p = .368), so we omitted this measure from our analyses, as it did not fit with our conceptual model of children's "will" to pursue academic work. However, we did explore the inclusion of the measure of growth mindset in our model as a supplemental analysis below. These were the only deviations we made from our preregistered analyses.

We use lagged models, controlling for literacy and numeracy in the fall, to reduce selection bias. Controlling for lagged scores in addition to a range of family and child demographic covariates adjusts for unobserved or omitted variables associated with the lagged outcome. This approach is recommended given that measures of each outcome are repeated exactly in the two waves (National Institute of Child Health and Human Development Early Child Care Research Network & Duncan, 2003). We estimated covariate pathways (child age, region, child gender, parent treatment status, teacher treatment status, parental education, and household income) on literacy and numeracy in the spring. We also allowed for covariation between all variables drawn from the fall: Digit Span, Hearts & Flowers, the two motivation measures, literacy and numeracy in the fall, and the covariates. Finally, we allowed for covariation between literacy and numeracy in the spring. Whenever EFs, motivation, or both EFs and motivation showed significant associations with children's academic growth, exploratory analyses were conducted to examine whether associations in the model operated similarly for males and females and for children of parents with no formal education and some formal education using multiple group analyses.

Results

Descriptive Statistics and Bivariate Correlations

Descriptive statistics for all study variables are presented in Table 1 and bivariate correlations between all study variables are presented in Table 2. Overall, rates of missing data were relatively low. On variables drawn from the fall, rates of missing ranged from 1.00% (motivation, EFs) to 1.56% (literacy). Approximately 8.39% of children did not complete achievement measures in the spring. Rates of missing on covariate measures were exceptionally low, ranging from .00% (child gender) to 1.83% (child age), except for household income (10.52% missing data).

Overall, children reported relatively high intrinsic and extrinsic motivation (intrinsic M = 4.545, SD = .712; extrinsic M = 4.376, SD = .765; ranges: 1–5). We found significant variability in children's EFs, such that children received an average score of 2.43 digits (SD = .94 digits) on the Digit Span task and 72.60% (SD = 19.65%) on the Hearts & Flowers task. There was slight evidence of ceiling effects on the Hearts & Flowers task, such that 21.58% of the children received the maximum score on the task. Very few children (.32%) received the maximum score of six digits on the Digit Span task. On average, children responded correctly to 22.8% of the literacy items (SD = 18.9%) and 50.0% of the numeracy items (SD = 22.2%) in the fall. Scores increased in the spring; children correctly responded to 28.5% of the literacy items (SD = 21.5%) and 57.6% of the numeracy items (SD = 21.4%), on average. Children were 8.7 years old, on average, with 95% of the sample falling between the ages of 6 and 12. Our sample was representative of classroom rosters in each grade level and is representative of common underage and overage enrollment in Ivorian schools. Parents reported relatively low levels of education (M = 4.1 years, SD = 4.6 years) and household income (M = 77,007 CFA francs/month, equivalent to $129 USD/month; SD = 89,505 CFA francs/month, equivalent to $150 USD/month). For comparison, the international benchmark for poverty is $1.90/day ($57/month), so families with three or more household members would be living in poverty at the average household income level of this sample.

Table 1
Descriptive Statistics

Variable	N	M/%	SD	Range
Intrinsic motivation (fall)	2,475	4.545	0.712	1–5
Extrinsic motivation (fall)	2,475	4.376	0.765	1–5
Digit span (fall)	2,475	0.726	0.197	0–1
Hearts & Flowers (fall)	2,475	2.432	0.937	1–6
Literacy (fall)	2,461	0.228	0.189	0–0.920
Literacy (spring)	2,500	0.285	0.215	0–0.953
Numeracy (fall)	2,475	0.500	0.222	0–0.933
Numeracy (spring)	2,500	0.576	0.214	0–0.983
Covariates				
Child age	2,679	8.653	1.978	3–18
Region	2,704	50.04%		0–1
Male child	2,729	49.98%		0–1
Parent treatment	2,729	49.32%		0–1
Teacher treatment	2,729	50.71%		0–1
Parental education	2,715	4.057	4.602	0–16
Household income (1,000 CFA francs /month)	2,442	77.007	89.505	5–350

Path Analysis Model

The main model was a path analysis with observed variables for Digit Span, Hearts & Flowers, intrinsic motivation, and extrinsic motivation predicting spring literacy and numeracy skills. Fit statistics indicated good model fit (CFI = .961; TLI = .956; RMSEA = .055, 90% confidence interval [.048, .062]; SRMR = .018). All standardized path coefficients for the primary pathways of interest are presented in Table 3 and displayed in Figure 1. All standardized path coefficients for covariate pathways are presented in Table 4.

As expected, there was significant longitudinal continuity between literacy at fall and spring (β = .631, p < .001) and numeracy at fall and spring (β = .645, p < .001). Intrinsic motivation and Digit Span uniquely contributed to spring literacy skills (β = .034, p = .030; β = .121, p < .001, respectively), whereas extrinsic motivation was not associated with spring literacy skills (β = −.022, p = .162) and the Hearts & Flowers task only showed a trend-level positive association with spring literacy skills (β = .026, p = .081). In contrast, only Digit Span was linked to children's spring numeracy skills (β = .118, p < .001), with no significant associations between intrinsic motivation, extrinsic motivation, or Hearts & Flowers for children's spring numeracy skills (β = .018, p = .271; β = −.014, p = .338; β = .010, p = .511; respectively).

There were also some notable covariate associations with academic achievement in the spring. Child age was a significant predictor of spring literacy and numeracy skills (β = .058, p < .001; β = .076, p < .001; respectively), even after controlling for lagged fall achievement, suggesting that older children learn more over the school year. Parental education and household income were uniquely associated with growth in children's literacy skills (β = .059, p < .001; β = .031, p = .049; respectively), whereas only parental education was linked to growth in numeracy skills (β = .036, p = .014).

Exploratory Analyses and Robustness Checks

Multiple group analyses tested child gender and parental education differences in the hypothesized path analytic model. We did not find any significant differences by gender in our main path analytic model (see the online supplemental materials, pp. S6–S7). With regards to parental education, we found that only the Digit Span task was linked to growth in literacy and numeracy skills for children whose parents had no formal education. However, for children whose parents had some formal education, both intrinsic motivation and the Digit Span task were uniquely associated with growth in literacy skills, and the Digit Span task was linked to growth in numeracy skills (see the online supplemental materials, pp. S8–S9). Follow-up chi-square difference testing validated that this pathway was significantly different for children whose parents have no formal education and some formal education (χ^2(1, N = 2715) = 6.53, p = .011).

We ran a series of alternative models to test the robustness of our findings to various specifications. First, we examined whether the restriction of our sample to children ages 6 to 12 would impact the results, by dropping the 5.45% of the sample that was outside of this age range. We find that results were largely the same, with a small decrease in the association between intrinsic motivation and literacy skills (β = .027, p = .091), a small increase in the association between Hearts & Flowers and literacy skills (β = .030, p = .053), and small increases in the association between Digit Span

Table 2
Bivariate Correlations Among All Study Variables

No.	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Intrinsic motivation	—													
2.	Extrinsic motivation	.43***	—												
3.	Hearts & Flowers	.15***	.00	—											
4.	Digit Span	.14***	.01	.31***	—										
5.	Literacy (fall)	.21***	.07**	.32***	.49***	—									
6	Literacy (spring)	.25***	.11***	.38***	.53***	.76***	—								
7.	Numeracy (fall)	.19***	.07**	.32***	.55***	.73***	.62***	—							
8.	Numeracy (spring)	.24***	.12***	.41***	.63***	.68***	.73***	.79***	—						
9.	Child age	.04	−.02	.15***	.37***	.28***	.31***	.40***	.47***	—					
10.	Bouaflé region	.09***	.07***	.07***	.15***	.17***	.18***	.12***	.15***	−.14***	—				
11.	Male child	.00	.00	.03	.02	.01	.00	.08***	.07***	.07***	−.04	—			
12.	Parent treatment	.00	−.02	.03	.00	.05*	.03	.03	.01	.01	.01	−.04	—		
13.	Teacher treatment	.03	.04	−.06*	.02	−.02	.03	−.01	.01	.01	.01	.00	.02	—	
14.	Parental education	.08***	.03	.05*	.09***	.20***	.18***	.11***	.10***	−.19***	.14***	.01	.03	.00	—
15.	Household income	.06**	.02	.05*	.10***	.15***	.13***	.11***	.11***	−.07***	.12***	.02	.07***	.04	.37***

Note. Parent treatment = parent intervention treatment; Teacher treatment = teacher intervention treatment. Omitted region is Aboisso region.
* $p < .05$. ** $p < .01$. *** $p < .001$.

and both literacy and numeracy skills ($\beta = .126$, $p < .001$; $\beta = .122$, $p < .001$, respectively). This provides evidence that our results are not driven by children who are much younger or older than expected for Grades 2 and 4.

Second, we included the measure of growth mindset to our main path analysis model and did not find any unique associations between growth mindset and literacy or numeracy in the spring ($\beta = .014$, $p = .352$; $\beta = -.016$, $p = .248$, respectively). Given the measurement concerns, we are not confident about whether this is a true null effect or indicative of issues with the measure. Third, we explored inclusion of cross-lagged pathways between literacy in the fall and numeracy in the spring and vice versa. These results demonstrated significant links between literacy in the fall and numeracy in the spring and numeracy in the fall and literacy in the spring (see the online supplemental materials, pp. S4–S5). However, it is unclear if these reflect true cross-domain contributions of literacy and numeracy skills to each other or the effects of unmeasured confounds on academic achievement across different domains, such as general cognitive skills (Bailey et al., 2020). Finally, we conducted our main path analytic model using latent variables for EFs and motivation, instead of separate, observed variables. Similar to our presented results, we found significant associations of an EF composite measure (with both Digit Span and Hearts & Flowers) for both literacy and numeracy skills in the spring. The latent motivation variable (including both intrinsic and extrinsic motivation) was not associated with spring achievement measures. Details on this analysis can be found in our online supplemental materials (pp. S1–S3).

Discussion

This study was among the first to apply the self-regulated learning model to assess learning outcomes among primary school students in a low- and middle-income context. Results provide evidence that both working memory skills and children's intrinsic motivation play a unique role in the school success of primary schoolchildren in rural Côte d'Ivoire. Specifically, we find that working memory and intrinsic motivation are linked to growth in children's literacy skills, whereas only working memory is associated with growth in children's numeracy skills. Extrinsic motivation and a task measuring inhibitory control/cognitive flexibility, on the other hand, were not associated with growth in either outcome. Our results demonstrate that self-regulated learning, and EFs in particular, is important even in classroom contexts that are teacher-directed and where children have often limited autonomy over their learning process (Dembélé & Lefoka, 2007). Given low rates of academic achievement in the region, this study suggests that supporting children's self-regulation skills and their intrinsic motivation to learn could be important pathways to improve their literacy and numeracy skills.

EFs and Motivation Support Learning in Côte d'Ivoire

Self-regulated learning theory highlights the shared importance of children's abilities to regulate their attention and behaviors and their will to do so in the classroom for successful learning and engagement. Indeed, our results show that both EFs and motivation uniquely contributed to students' literacy skills in Ivoirian primary schools, though EFs were much stronger predictors of achievement than motivation. Our results align with previous research demonstrating that EF skills

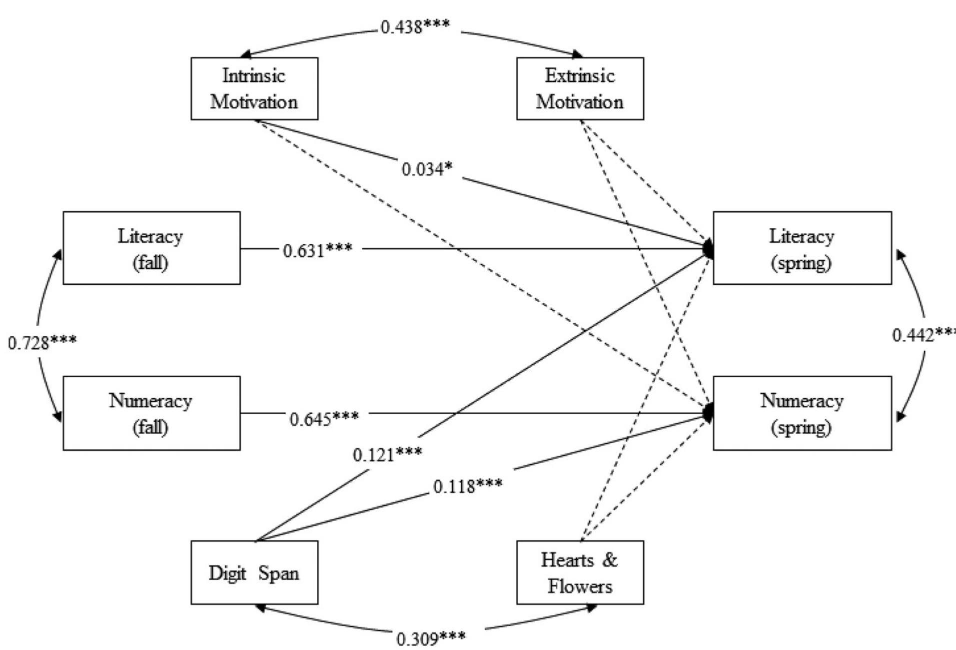
Table 3
Standardized Coefficients for Direct Pathways of Key Study Variables

Pathway	β	*SE*	*t*	*p*
Literacy (spring)				
Literacy (fall) → literacy (spring)	0.631	0.016	38.271	<.001
Intrinsic motivation → literacy (spring)	0.034	0.016	2.172	.030
Extrinsic motivation → literacy (spring)	−0.022	0.016	−1.399	.162
Digit span → literacy (spring)	0.121	0.017	7.141	<.001
Hearts & Flowers → literacy (spring)	0.026	0.015	1.743	.081
Numeracy (spring)				
Numeracy (fall) → numeracy (spring)	0.645	0.018	35.398	<.001
Intrinsic motivation → numeracy (spring)	0.018	0.016	1.100	.271
Extrinsic motivation → numeracy (spring)	−0.014	0.015	−0.958	.338
Digit span → numeracy (spring)	0.118	0.017	6.911	<.001
Hearts & Flowers → numeracy (spring)	0.010	0.015	0.657	.511

support academic learning during the school year. A recent meta-analysis of studies across primary school students in high-income countries found that direct assessments of EFs were linked to both reading and mathematics skills (Cortés Pascual et al., 2019). Further, a study in Kenya, another sub-Saharan African country, showed that preprimary school students' EFs were significantly linked to preliteracy and prenumeracy skills measured concurrently (Willoughby et al., 2019). We show that EFs are linked with *longitudinal changes* in primary school students' academic skills in Côte d'Ivoire, building on work by Wolf and McCoy (2019b) in the neighboring country of Ghana, demonstrating that a composite EF measure was linked to growth in literacy and numeracy skills in preprimary school students over 2 school years. The findings provide further evidence of EFs as a universally beneficial set of skills for children across various cultural contexts (Obradović et al., 2019; Obradović & Willoughby, 2019).

Further, we found links between a measure of working memory, but not cognitive flexibility with achievement in our sample. In the United States and Europe, there is evidence of the unique importance of working memory, or children's abilities to hold and manipulate information in the brain, for academic achievement (Allan et al., 2014; Bull & Scerif, 2001; Nguyen & Duncan, 2019; Peng et al., 2018). Specifically, in two large samples of children from the United States, working memory in early childhood was most strongly associated with later reading and mathematics achievement, compared to inhibitory control, cognitive flexibility, and attention, after controlling for previous achievement and demographic covariates (Ahmed et al., 2019;

Figure 1
Main Path Analytic Model With Standardized Estimates



Note. Standardized estimates are presented. Covariate pathways are not shown.
* $p < .05$. *** $p < .001$.

Table 4
Standardized Coefficients for Covariate Pathways

Pathway	β	*SE*	*t*	*p*
Literacy (spring)				
Child age → literacy (spring)	0.058	0.016	3.552	<.001
Bouaflé region → literacy (spring)	0.036	0.014	2.579	.010
Male child → literacy (spring)	0.000	0.013	0.031	.975
Parent treatment → literacy (spring)	0.033	0.013	2.468	.014
Teacher treatment → literacy (spring)	−0.036	0.013	−2.727	.006
Parental education → literacy (spring)	0.059	0.015	3.909	<.001
Household income → literacy (spring)	0.031	0.016	1.970	.049
Numeracy (spring)				
Child age → numeracy (spring)	0.076	0.016	4.759	<.001
Bouaflé region → numeracy (spring)	0.017	0.013	1.244	.214
Male child → numeracy (spring)	0.023	0.013	1.757	.079
Parent treatment → numeracy (spring)	0.024	0.013	1.882	.060
Teacher treatment → numeracy (spring)	−0.021	0.013	−1.612	.107
Parental education → numeracy (spring)	0.036	0.015	2.453	.014
Household income → numeracy (spring)	0.019	0.015	1.264	.206
Covariation with intrinsic motivation				
Intrinsic motivation with extrinsic motivation	0.438	0.021	20.816	<.001
Intrinsic motivation with digit span	0.133	0.019	6.960	<.001
Intrinsic motivation with Hearts & Flowers	0.141	0.019	7.492	<.001
Child age with intrinsic motivation	0.036	0.020	1.816	.069
Bouaflé region with intrinsic motivation	0.103	0.020	5.194	<.001
Male child with intrinsic motivation	−0.015	0.020	−0.766	.444
Parental education with intrinsic motivation	0.091	0.018	5.171	<.001
Household income with intrinsic motivation	0.053	0.019	2.760	.006
Covariation with extrinsic motivation				
Digit span with extrinsic motivation	0.018	0.020	0.912	.362
Hearts & Flowers with extrinsic motivation	0.010	0.020	0.511	.610
Child age with extrinsic motivation	−0.015	0.021	−0.738	.460
Bouaflé region with extrinsic motivation	0.082	0.020	4.152	<.001
Male child with extrinsic motivation	−0.005	0.020	−0.270	.788
Parental education with extrinsic motivation	0.031	0.020	1.589	.112
Household income with extrinsic motivation	0.020	0.021	0.944	.345
Covariation with digit span				
Inhibitory control with digit span	0.309	0.018	17.124	<.001
Child age with digit span	0.355	0.017	21.231	<.001
Bouaflé region with digit span	0.147	0.019	7.690	<.001
Male child with digit span	0.033	0.020	1.670	.095
Parental education with digit span	0.087	0.021	4.228	<.001
Household income with digit span	0.087	0.022	3.947	<.001
Covariation with Hearts & Flowers				
Child age with Hearts & Flowers	0.131	0.020	6.581	<.001
Bouaflé region with Hearts & Flowers	0.063	0.020	3.140	.002
Male child with Hearts & Flowers	0.031	0.020	1.552	.121
Parental education with Hearts & Flowers	0.052	0.020	2.594	.009
Household income with Hearts & Flowers	0.046	0.020	2.248	.025
Covariation with literacy (fall)				
Numeracy (fall) with literacy (fall)	0.728	0.008	93.027	<.001
Intrinsic motivation with literacy (fall)	0.243	0.015	16.674	<.001
Extrinsic motivation with literacy (fall)	0.121	0.019	6.489	<.001
Digit span with literacy (fall)	0.532	0.015	35.677	<.001
Hearts & Flowers with literacy (fall)	0.369	0.017	21.205	<.001
Child age with literacy (fall)	0.302	0.017	17.285	<.001
Bouaflé region with literacy (fall)	0.177	0.019	9.437	<.001
Male child with literacy (fall)	0.009	0.020	0.473	.636
Parental education with literacy (fall)	0.194	0.021	9.105	<.001
Household income with literacy (fall)	0.128	0.022	5.882	<.001
Covariation with numeracy (fall)				
Intrinsic motivation with numeracy (fall)	0.236	0.019	12.598	<.001
Extrinsic motivation with numeracy (fall)	0.126	0.020	6.261	<.001
Digit span with numeracy (fall)	0.628	0.012	52.785	<.001
Hearts & Flowers with numeracy (fall)	0.406	0.017	23.635	<.001
Child age with numeracy (fall)	0.456	0.015	31.174	<.001
Bouaflé region with numeracy (fall)	0.145	0.019	7.606	<.001
Male child with numeracy (fall)	0.088	0.019	4.533	<.001

(*table continues*)

Table 4 (*continued*)

Pathway	β	*SE*	*t*	*p*
Parental education with numeracy (fall)	0.099	0.020	5.084	<.001
Household income with numeracy (fall)	0.108	0.020	5.541	<.001
Covariation with covariates				
Child age with Bouaflé region	−0.144	0.019	−7.650	<.001
Child age with male child	0.069	0.019	3.603	<.001
Child age with parental education	−0.187	0.018	−10.538	<.001
Child age with household income	−0.068	0.021	−3.255	.001
Bouaflé region with male child	−0.028	0.019	−1.481	.139
Bouaflé region with parental education	0.146	0.019	7.770	<.001
Bouaflé region with household income	0.116	0.020	5.838	<.001
Male child with parental education	0.007	0.019	0.371	.710
Male child with household income	0.013	0.020	0.635	.525
Parental education with household income	0.362	0.023	15.721	<.001
Literacy (spring) with numeracy (spring)	0.442	0.017	26.151	<.001

Nguyen & Duncan, 2019). However, previous studies examining the role of EFs in sub-Saharan Africa have generally used composite measures across multiple tasks, given research demonstrating EFs as a unitary factor in early childhood (Willoughby et al., 2012, 2019; Wolf et al., 2019; Wolf & McCoy, 2019b). It is plausible that differences in EF components were masked by averaging across the tasks, and our findings suggest that future research should disaggregate EF tasks to examine whether there are unique effects across EF components for learning outcomes.

In our sample, intrinsic motivation had a unique, though smaller, association with literacy, which is in line with previous research in the United States demonstrating that EFs play a much larger role in academic growth compared to motivation (Howse et al., 2003; Sulik et al., 2020). However, we demonstrated significant effects of motivation only for changes in literacy skills, whereas Sulik and colleagues (2020) only showed a significant effect of intrinsic motivation for mathematics and not literacy skills, when controlling for prior academic skills and EFs in a sample of American primary school students. This finding provides initial support for the hypothesis that motivation is important for developing early literacy skills for children in sub-Saharan Africa, where classroom contexts are generally less participatory in nature and learning activities are rarely individualized (Tabulawa, 2013).

The larger effect sizes for EFs, compared to motivation, may be due to the foundational nature of EFs for learning process. EFs are linked to academic success through both the direct understanding of basic literacy and numerical skills (Cartwright, 2012; Kroesbergen et al., 2009) and through its contributions to adaptive classroom behaviors that allow children to focus and pay attention (Finch & Obradović, 2017; Nelson et al., 2017). Following the self-regulated learning model, children first need the ability to regulate their behaviors (EFs) before their motivation in applying these self-regulation skills is beneficial to their learning. Our results support the notion that EFs underpin children's abilities to learn in an academic setting across different cultural contexts (Obradović & Willoughby, 2019).

The Role of Socioeconomic Status and Gender for Nonacademic Skills and Achievement

In sub-Saharan Africa, and Côte d'Ivoire in particular, there are significant gender disparities in primary school enrollment and retention (UNESCO Institute for Statistics, 2018). Disparities are particularly pronounced in low-income households, as the family economic situation and subjective well-being are more strongly linked to girls' likelihood of attending school compared to boys' (Koissy-Kpein, 2020). Similarly, parents who did not attend school themselves are significantly more likely to be low-income and may prioritize children's financial contributions to the family over attending school. Lower levels of parental education are linked to lower rates of schooling and academic achievement for their children (Glick & Sahn, 2000; Pufall et al., 2016). Therefore, girls and children who parents did not have any formal schooling are particularly disadvantaged in sub-Saharan Africa, compared to their peers.

Follow-up analyses demonstrated that there were not significant differences in the role of nonacademic skills for achievement between boys and girls. In many ways, this is heartening. It suggests that efforts to support EFs and motivation in the classroom would benefit both boys and girls equally. Further, there were few gender differences in children's nonacademic skills or achievement. The only two significant pathways for child gender in the main model was for covariation with children's fall numeracy skills and age, such that boys had higher scores on the numeracy test than girls and boys were older than girls. However, these gender differences were not apparent for literacy scores, nor either measure of EFs or motivation. This suggests that boys begin the school year with stronger numeracy skills and that they likely remain in school longer than girls, on average, which aligns with previous research in the region highlighting that girls face larger barriers to accessing and attending school than boys (UNESCO, 2021; Wolf et al., 2016).

In line with a growing body of research in low- and middle-income countries, measures of socioeconomic status were highly predictive of children's EFs and achievement (Obradović et al., 2019; Sania et al., 2019; Wolf & McCoy, 2019a; Zuilkowski et al., 2019). We found much larger associations of parental education than household income (approximately 2 times larger) with children's EFs and achievement, providing evidence that in this context parental education may be a stronger measure of the types of household contexts that support self-regulation development. This is similar to a recent study of Chinese immigrant families in the United States demonstrating a significant effect of parental education, but not family income, on authoritative parenting and

EFs (Chen et al., 2021). However, in the current study, parental education and household income were uniquely associated with both measures of EFs and literacy, suggesting that they each play a role in supporting children's self-regulation and school success. Similarly, in Zambia, wealth and parental education were indirectly linked to 6-year-olds' EFs via home-based cognitive stimulation and access to early childhood education (McCoy et al., 2015). Parental education and income also significantly covaried with intrinsic motivation, suggesting that higher socioeconomic status families may place more emphasis on the process of learning, compared to lower socioeconomic status families.

Implications for Children's Educational Experiences

Theoretically, the numerous interventions implemented in low-performing educational systems, including scripts for teachers, provision of learning materials, and coaching, influence students' learning outcomes via changes in teachers' classroom practices (Fleisch et al., 2016). There is growing evidence that making classrooms more activity-based and child-centered improves learning, EFs, and social-emotional development in sustained ways (Conn, 2017; Wolf, 2019; Wolf et al., 2019). Enhancing the quality of classrooms will likely provide more opportunities for children to practice and improve their EFs and increase their motivation toward learning. In high-income countries, teachers who offer choices, opportunities to control the challenge of activities, scaffold instruction, and make evaluation nonthreatening and mastery-oriented, increase levels of self-regulated learning in their students (Perry et al., 2002). It is important to note that there may be significant barriers for teachers in sub-Saharan Africa to provide high-quality learning environments for their students. For example, teachers may be underprepared and not have the necessary content knowledge about the subjects they are asked to teach. Many teachers in low-income settings are themselves living in poverty and experiencing stress and physical and mental health challenges that can undermine their abilities to teach effectively (Schwartz et al., 2019). To increase the overall quality of education in sub-Saharan Africa, it will be crucial to address systemic barriers plaguing teachers by providing high-quality preservice and in-service training on child-centered learning approaches. If educational interventions are to be effective, they need to address both student and teacher needs (Evans & Yuan, 2018).

Another opportunity to improve children's EFs and early achievement is through access to high-quality early childhood education programs. In Côte d'Ivoire, very few children (5.7%) attend early childhood education programs, and nearly half of children experience both low levels of cognitive stimulation at home and do not attend early childhood education programs according to UNICEF's Multiple Indicator Cluster Survey program (McCoy et al., 2018). Attendance in early childhood education programs with individualized supports for students leads to more efficient primary school education, as these students are significantly less likely to have to repeat grades once they begin formal schooling (Gove, 2017). A new Accelerated School Readiness program piloted by the Ivorian government to boost the academic skills of children entering primary school with no preprimary school experiences is a promising intervention that will likely have cascading effects on children's later primary school achievement (Education Partnerships Group, 2022). Increasing access to preprimary education and programming may not only increase achievement, EFs, and other important adaptive classroom behaviors, but may also support learning-related motivation by producing early academic experiences and success (McCoy et al., 2017; Obradović & Willoughby, 2019; Rao et al., 2012; Wolf et al., 2019).

Limitations and Conclusions

While this study provided initial evidence of the importance of nonacademic skills for children's literacy and numeracy achievement in sub-Saharan Africa, there are some limitations that provide important avenues for future research. First, there may be a lack of generalizability outside of the schools and students in these two rural regions of Côte d'Ivoire. Sub-Saharan Africa is highly diverse and predictors of learning in one region may not be the same somewhere else. Second, we only included two measures of children's EFs. Typically, larger batteries of EF tasks are preferable, as they provide more coverage of the various aspects of EFs and allow for more precise measurement of EFs (Obradović & Willoughby, 2019). Third, while our analyses include a robust set of demographic control variables and lagged measures of children's literacy and numeracy skills, they are correlational and should not be interpreted causally. There is still the possibility of confounding effects and omitted variable biases, for example, unobserved teacher-level factors could partially explain the results. It is also possible that children with higher baseline rates of EFs and motivation select into higher quality classrooms based on unobserved factors, such as parent motivation. Future studies with three or more time points of academic achievement, EFs, and motivation could employ more sophisticated models, such as random intercept cross-lagged panel models, which account for unmeasured confounds that impact achievement across years and also explore cross-domain links between literacy and numeracy skills in the Ivorian context (Bailey et al., 2020). Finally, we used a self-report measure of children's motivation that may not capture children's actual behaviors when presented with choices in academic setting. There is a pressing need for scalable direct assessments of motivation that can be easily administered in classroom settings.

As governments around the world strive to provide high-quality education and learning opportunities to all children, building more evidence about which factors support learning will inform how to make these efforts more effective. This is particularly true for rural sub-Saharan African communities, where few such studies exist to date (Nielsen et al., 2017). Findings from this study provide evidence that nonacademic skills are key predictors of growth in literacy and numeracy over the school year in Côte d'Ivoire. These skills may be particularly important given that classrooms are large, with few opportunities for students to engage with teachers and peers. Finally, improving the quality of classroom interactions in this context would likely support learning directly and via increases in student EFs and motivation. Additional research in this area is needed in order to contribute to a cross-cultural research program that is critical for understanding child development and education from a global perspective, and if global efforts to improve educational quality and child development are to succeed.

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