International Journal of Learning and Development
ISSN 2164-4063
2026, Vol. 16, No. 1

Preschoolers Executive Functions and Quality of Teacher-Child Interaction on Embedded Cognitive Activity: A Ghanaian Study

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Received: January 11, 2026 Accepted: February 28, 2026 Published: March 25, 2026

doi:10.5296/ijld.v16i1.21578 URL: https://doi.org/10.5296/ijld.v16i1.21578

Abstract

This study examined three questions: how reading with embedded cognitive activity foster preschoolers' executive functions; what variations exist between groups exposed to embedded cognitive activity and a control group that lacked executive functions engagements and how reading a story with embedded cognitive control varied across three months post intervention period. Using pretest-posttest design with random sampling of estimated 40 kindergarten children, the study measured their executive functions on three variables: Working Memory retention, Inhibition Control and Set Shifting. Overall, the findings indicate that the effect of reading stories with embedded executive function (EF) activities remained strong after the training and across the three-month post-intervention period. Participants in the experimental group consistently demonstrated higher EF activities scores than those in the control group. The similarity in group variances confirmed that the comparison was statistically appropriate. The one-way ANOVA showed a significant difference between groups, while the very large effect size estimates suggest that the sustained differences in EF performance over the three months were largely attributable to the intervention. This implies that the EF-embedded reading activities produced a stable and lasting improvement in executive functioning during the follow-up period.

Keywords: Executive Functions; Embedded Cognitive Activities; Teacher-Child Interaction; Preschoolers

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1. Introduction

Executive functions (EF) are cognitive processes that help people to adapt to novel situations and exert behavioral control (Diamond, 2013; Morosanova et al., 2022; Silva et al., 2022). They are integral to both cognitive and social development as well as developing behavioral self-regulation (Blair, 2002). Early Childhood executive functions assist children to monitor their progress, inhibit automatic impulses, so that attention can be focused on appropriate learning strategies. Automatic impulse control is linked to developing positive attitude towards learning behaviors (McClelland et al., 2007; Welsh et al., 2010; Zhang et al., 2017). They also predict learning, academic success, health, well-being, economic status and social actions across life span (Moffit et al, 2011; Wanless et al 2016; Russel et al. 2016; Zelano & Carlson, 2020). EF consist of three components: a) *Working Memory* (retaining and using both visual and verbal information); b) *Cognitive flexibility* (skills to switch between tasks, such as rules, and stimuli) and c) *Inhibitory control* (one's ability to resist habits, distractions and temptations) to stay focused (Miyake et al., 2000). They are seen to be most active during the preschool years. They also have crucial impact on children's subsequent performance (Anderson, 2001; Zelazo & Müller, 2002). Copious evidence suggests positive correlation of EF and preschoolers' academic performance in language, mathematic and problem-solving skills (Bull et al., 2008; Clements et al., 2016; Cortés Pascual et al., 2019; Oshchepkova & Shatskaya, 2023). There is also empirical evidence that children with high level of EF tend to be more academically successful, compared to those with minimal EF (Cortés Pascual et al., 2019). Given the contemporary focus on Early Childhood Education, increasing academic interest to examine how and what factors contribute to EF development at this level, is crucial. Preschool environmental factors, such as, opportunities for interacting with peers increase their EF. (Vandell et al., 2010; Ghardashi et al., 2013; Hall et al., 2013; Sylva et al., 2014; Dean &Jayachandran, 2019). One critical factor identified to influence early childhood executive functions is warm and supportive teacher-child interaction quality. It promotes emotional security, reducing stress, and allowing children to better regulate attention, working memory and behavior. Conversely, high-conflict relationship hinders EF development, leading to lower academic performance and self-regulation (Williford et al., 2013, 2016; Veraksa A. N. et al., 2020).

1.1 Statement of Problem

The preschool years 3-5, are known to be a crucial period that signifies executive functions development in children (Carlson, 2005; Garon et al, 2008). The literature on children's executive functions is consistent that they constitute the foundational building blocks for children's learning. Additionally, children's executive functions also have critical influence in many developmental outcomes, such as school readiness, social competence and school performance (Almy & Zelazo, 2015; Madanipour & Cohrssen, 2024). Similarly, teacher-child interactions have equally been cited to be critical determinants of children outcomes and executive functions (Pianta & Hamre, 2009; Wang et al, 2020; Bernier et al., 2010; Paro et al., 2009; Bodrova & Leong, 2007). Thus, while many empirical studies have been conducted on children's executive functions from the perspective of school readiness (Philip et al. 2017), classroom experience (Yoshikawa et al., 2013), teacher-child interactions (Pianta & Hamre, 2009; Wang et al, 2020; Bernier et al., 2010; Paro et al., 2009; Bodrova & Leong, 2007), little is known about how the combined teacher-student interaction with embedded cognitive activity that foster preschoolers' executive functions. This is the gap that this study intends to fill. Additionally, few studies have been conducted to examine whether or not, long lasting variations do exist between groups pedagogically exposed to embedded cognitive activity, and a control group, lacking engagements of executive functions, long after exposure to training. This is especially compelling, given that some of the studies on teacher-child interactions on children's executive functions remain contradictory. (Burchinal et al., 2010; Weiland et al., 2013; Hill et al., 2015; Gong et al., 2016). In addition, 'Classroom Assessment Scoring System' (CLASS) tool has been used in other geopolitical areas to study children's executive functions. Studies using this same instrument to measure EF is minimal in the study area, hence the need to address this shortfall in the literature, using this scoring system, with the view to comparing findings across geopolitical areas.

1.2 Research Questions

The subsequent three questions underscored this research:

1) How does reading with embedded cognitive activities in individual and group contexts foster preschoolers' executive functions (EF)?

2) What variations exist between groups exposed to embedded cognitive and a control group that lacked engagements of executive functions (EF)?

3) How does reading a story having Cognitive Control activity embedded varied across three months post-intervention period?

1.3 Significance of the Study

One critical benchmark to evaluate Early Childhood Education (ECE) quality to monitor if public investments are properly being utilized effectively, is to identify the shortfalls of ECE and suggest indicators for improvement. Consequently, the findings of this study will benefit stakeholders of preschool education: parents, preschool teachers, child psychologists, etc. Access to quality ECE for all Children by 2030 is a top agenda in Ghana's Education Strategic Plan. It is against this background that the findings of this research will constitute one of the high-stakes reliance to evaluating teacher-child interactions and children's effective use of their Executive Functions.

2. Theoretical Framework/Literature Review

2.1 How Executive Functions develop

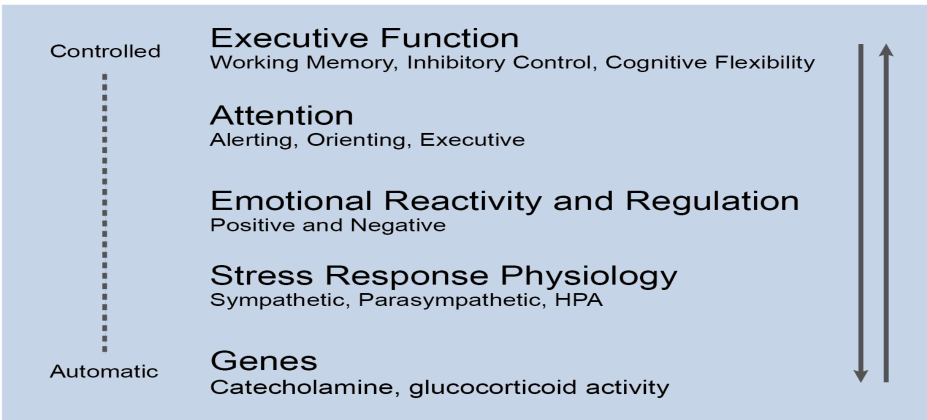
2.1.1 Levels of Approach of Executive Functions: Iterative Reprocessing Model

Studies on Executive Functions involve multiple levels: brain, cognition, behavior and the neurons. Zelazo, Blair and Willoughby (2016) elucidate the relations of the levels of analyses. They describe how attention control implicates goal directed problem solving. These authors stipulate three levels of analyses of Executive Functions (EF): *Neural, Cognitive, and Behavioral* and their educational/pedagogical implications. Basing discussion on the *Iterative*

Reprocessing model (cf. Cunningham & Zelazo 2007; Zelazo 2015), they demonstrate how executive function regulates attention, and hence how they are able to control behaviors to become adaptive, focused and planful. This process becomes partially enabled as result of efficient increases of *reflection:* how children are able to identify obstructions, halt, and focus on other alternatives. Having reflected on given instance, they then execute EF skills: flexibility in cognition, working memory and inhibitory control. On the other hand, if responses to situations are reactive, with less reflection on their activities, they are likely to demonstrate failures. Thus, *Iterative Reprocessing* model describes both processes involved with reflection, and how they foster particular EF skills to control behavior. There are other theoretical models such as Buss and Spencer 2014, Munakata, Snyder, and Chatham (2012, 2013).

2.2 Blair's Psychobiological Model

Blair's converging theoretical approach of EF is another model. It is psychological model based on a much broader construct of self-regulation (Blair 2014; Blair and Ursache 2011). The underlying idea is based on what is referred to as 'dual systems' or 'dual process' theory (Schneider & Shiffrin 1977). It highlights emotional and bodily (physiological) responses to stress. This model examines difference in executive control (EF) linked to genes connected to sensitivity and stimulation of emotions and how they respond to physiological stress, that precipitate neural activity in the prefrontal cortex (PFC). This examines one's ability to reflect on information at a much deeper level EF, which is, intentional, goal directed and top-down. Thus, in this psychobiological model, EF is: a) a component of self-regulation; b) it is either fostered or hindered as a result of emotion and stress.



(Psychobiological model of self-regulation in which EF is one component of a hierarchy of processes relevant to self-regulation as presented in Zelazo, P.D., Blair, & Willoughby, M.T. (2016).

2.3 Neural Basis for Executive Function and its Role in Preschool Education

2.3.1 Neural substrate Model

One of the widely researched studies of interest to developmental psychologists has been the relationship between neurology and Executive Functions, especially Working Memory (WM)

Inhibitory Control (IC) and Set Shifting Flexibility (SSF). Even though, distinct, they share a common confluence: attention allocation and behaviour control to meet adaptive goal (Friedman and Miyake, 2017, Miyake and Friedman, 2012, Miyake et al., 2000). Diamond (2002) was one of the key reviewers on the development of EF from infancy to early adulthood, focusing on the maturation of the prefrontal cortex (PFC) and integration from anatomy and biochemistry (Fiske & Holmboe, 2019). It is also evident that functional brain specialization for EF, keeps developing into adolescence ((Fiske & Holmboe, 2019). Thus, the neural basis of WM essentially located in the prefrontal cortex (PFC) with other interconnected regions of the brain, playing a key role is established (Constantinidis & Klingberg, 2016).

Inhibitory Control (IC), which is the ability to control inappropriate thoughts or actions also develop in specific brain regions, such as the frontal and the parietal lobes. IC specifically develops neurologically through the maturation of the fronto-striatal circuitry, when there is an increased activation and enhanced connectivity between the prefrontal cortex and basal ganglia. This maturation permits more enhanced as well as sustained control over responses (Durston et al 2002). In a study conducted by Fiske et al (2024), using functional near-infrared spectroscopy, findings suggested that when inhibition was required, the right prefrontal and parietal cortices were more activated.

Set Shifting Flexibility is one of the core components of Executive Function. It is also underscored by neural activity in various regions of the brain, primarily the prefrontal (PFC) as well as the anterior cingulate cortex (ACC). These areas work together with the other cortical and subcortical regions to switch between varied mental tasks. Neurotransmitters, such as dopamine is key. It helps in motivation, reward as well as cognitive flexibility and in maintaining relevant information in the Working Memory (Waltz, 2016; Riedel et al., 2022)., Serotonin and acetylcholine also influence Set Shifting Behaviour by means of their modulation of prefrontal cortical function, since imbalance in these systems could lead to cognitive flexibility impairments. Thus, the ability of the brain to change and adapt to environmental response appears to be more pronounced in the early childhood period, from 0-6 years.

2.4 Teacher Child-Interaction and Executive Function Development

Consequent from the above, the high levels of plasticity and the extended maturation of the prefrontal cortex make EF development susceptible to environmental stimulation, such as, adult-child interactions and the features of the physical environment (e.g., Bernier et al., 2010; 2015; McClelland et al., 2018; Moriguchi, 2014; Vygotsky, 1978; Zelazo et al., 2016). Children are emotionally more connected to parents and teachers; they spend more time with such groups (Commodari, 2013; Roorda et al., 2011). Further, parents and teachers provide learning environment, supporting children emotionally, and cognitively offer more stimulating activities. The Attachment Theory, for example, posits that an emotional bond between children and parents helps children to feel secure, permitting them to explore environments independently, and learning from such explorations more easily (Commodari, 2013; O'Connor & McCartney, 2007). Considerable evidence supports the parent-child interaction as one of the key contexts for EF development. Parental positive response (responsiveness, warmth) and cognitive behaviors (e.g., scaffolding, autonomy support) strengthen EF abilities. Similarly, and simultaneously, negative parental behaviors (e.g., intrusiveness, control) are detrimental to EF development (Fay-Stammach et al., 2014; Valcan et al., 2017). Hence, teachers' classroom interaction plays a foundational role in shaping preschoolers executive function development. Examples of teacher positive behaviors, such as, emotional, instructional and an enabling classroom organization, etc., directly support children's EF growth.

2.5 Summary of Literature

Three key components of Executive functions underscored in the above literature are: Working Memory, Inhibitive Control and Cognitive Flexibility. All three foster young people's capability to focus and pay attention, remember what they are taught and demonstrate self-control. How they develop their neurophysiological foundations, as well as their environmental susceptibility, such as teacher-child interactions, have been examined. The two key issues central to this literature is that EF is both genetic and environmentally induced. Thus, for example, the high levels of plasticity as well as the long maturation of the brain's prefrontal cortex also makes Executive Functions sensitive to features of the physical environment.

2.6 Current Study

Given the evidence from the above literature that EF development is sensitive to adult-child interaction stimulation from the environment, this current study investigated whether or not, there is evidence for fostering EF in preschoolers' cognitive activity of reading an embedded text in adult-teacher intervention. Three research questions are explored: the first require children to control their thinking and behaviour through embedded cognitive activities; the second research questions examines the embedded reading of the experimental group against a control group that also engaged in embedded reading, but lacked any prior intervention of EF's .The third and final study is to test the effect of time duration on reading a text that has embedded EF. The objective is to provide evidence of intervention effects on how working memory shifts.

3. Methodology

3.1 Participants

This study used the pretest-postest experimental design. Forty (40) preschool children were recruited from a high-profile private kindergarten in one city in Ghana. They were assigned randomly into experimental and a control group of 20 children in each group with a mean average age of 4.87. In terms of parental socioeconomic background and education, both groups were of comparable, middle class socio-economic status. Children were normal with no learning difficulty and had no neurological or psychiatric disorders.

3.2 Intervention

In all, there were three interventions: Pre-test, Training and Post training

3.2.1 Pre-test Session

In this session, participants were tested on Interference Control. Three instruments were used:

a) day-night Stroop test; b) the Weschler Preschool and Primary Scale of Intelligence and c) Raven's Colored Progressive Matrices Test (36 items). The day-night Stroop measured inhibition. For example, Children were presented with image of a sun, mentioning girl when picture of a girls was shone. There were 32 cards, each lasting for 2 seconds. Outcome measure was based on the benchmark of the number of the correct answers given. A second test on inhibition was the Go*/no-go task:* two pairs of pictures were used as stimuli (moon and star; car and helicopter) presented for 200 milliseconds on a screen A record of the number of valid responses was taken. To assess response inhibition, alarms that were false (i.e., making a response when instructed not to respond) in the go/no-go task were used.

3.3 Training Session

The training session for the experimental group was on *Working Memory*, *Inhibition* and *Cognitive flexibility*. Working Memory was taught through Read and Report Task. Children were taught to read three short stories: *'A Message for the King'*; '*Grandma's Idea'; 'World's Finest Pie'.* They read one story per week for three weeks. They were taught how to describe key story elements with embedded questions such as: a) Who are the characters in the story? b) How are they feeling? c) what happens in the beginning of the story, middle and end? d) what element has the biggest impact on the story? The response inhibition was tested using an adapted version of the 'Fruit Ninja' (a commercial game) involving two categories of stimuli: fruit or a bomb. To inhibit their response to bomb, *no-go* stimuli was used. The 'go' stimuli was the fruit. Instructions to participants were to slice any of the fruits (go) as they were simultaneously informed not to touch bombs (no-go). Slicing of fruit was scored and recorded as one positive point. The experimental group was exposed to about four (4) training days each week, lasting 3 weeks totaling 12 sessions. The final score was the mean value of the three top scores. Age-appropriate Dimensional Change Card (DCCS) was used to train *Set Shifting Flexibility:* - a classroom-friendly game that assesses *Cognitive flexibility*, *Inhibition* and *Working Memory*. Participants were taught to sort cards based on shape. Later, they were asked to change the rule of sorting from shape to colour. Training was for 15 minutes each day for four training days, lasting for 3 weeks, making a total of 12 sessions. The control group also played some irrelevant games during these interventions, such as coloring some pictures in a book 15 minutes per day, twice in a week. The games were on psychomotor responses that were far less demanding cognitively.

3.4 Post Training Session

Twelve weeks after the training, similar tests were conducted to measure the three Executive functions for both groups- experimental and the control group.

4. Results

SPSS Statistics Version 30 (IBM Inc., NY, USA) was used. Two children having scores of two standard deviations in the pretest that used the Raven measure were not part of the analysis. This means that in total 38 children finished the study. Eighteen (18) of this number were in the training/experimental group, of which 12 were boys with mean age of 4.92. The control group had 20 children, out of which 10 were boys with mean age of 4.87. The two groups did not show any variation in respect of the measures assessed during the pre-test level using one-way analysis of variance (ANOVAs; $p > .113$, partial η 2 < .072, two-tailed for all comparisons).

4.1 Analysis of the Behavioral Data for Non-Trained Tasks

Means and standard deviation of non-trained tasks, plus post-test scores regarding the two groups are indicated in Table 1. A 2 (group: training vs. control group) x2 (based on gender boys vis-à-vis girls) ANCOVA (two-tailed) was run to determine a transfer effect. Post-test performance scores were used as dependent variable, while the pretest scores in each non-trained task were the (Bonferroni corrected for six comparisons, threshold at 0.05/6=0.008. No significant group effect was noticed in the go/no-go task. Again, there was also no indication of noticeable change in terms of gender after the training in the case of the Stroop task. However, the Raven's test showed a substantial significant trend $F(1, 31) = 4.962$, $p = .033$, partial η 2 = .138), but there was no effect of gender.

Table 1. Pre- and post-test performances on the non-trained tasks for the two groups**.**

Task				**Control group**	
		Pre-test Mean (SD)	**Post-test Mean (SD)**	**Pre-test Mean (SD)**	**Post-test Mean (SD)**
Digit span forward	boys	7.6 (1.4)	7.8 (1.7)	7.6 (1.3)	7.4 (1.3)
	girls	7.9 (1.1)	7.7 (0.8)	7.0 (1.9)	7.1 (1.7)
Digit span backward	boys	3.9 (1.7)	3.8 (1.6)	2.9 (0.7)	2.8 (0.4)
	girls	2.4 (0.5)	27 (0.6)	2.4 (0.8)	2.4 (0.5)
Advanced Stroop	boys	29.2 (1.6)	29 (1.7)	27.7 (1.9)	26.8 (2.1)
	girls	27.9 (1.5)	28 (0.8)	26.9 (2.2)	27.2 (1.5)
Raven's Matrices	boys	22.4 (5.2)	26.4 (4.8)	21.2 (4.7)	20.2 (6.8)
	girls	18.6 (1.8)	20.4 (2.9)	18.2 (3.3)	19.7 (2.5)
False Alarm (%)	boys	22.4 (18.2)	15.7 (14.5)	15.8 (5.3)	14.8 (5.9)
	girls	17.5 (15.9)	17.5 (14.2)	16.2 (12.1)	13.6(13.0)

4.2 Training Task Performance Analysis

The training tasks answered the first two research questions: a) How does reading with embedded cognitive activities in individual and group contexts foster preschoolers' executive functions (EF)? and b) What variations exist between groups exposed to embedded cognitive and a control group that lacked engagements of executive functions (EF)? Table 2 shows the variations between groups exposed to embedded cognitive activities as against the control.

Table 2. Variations between groups exposed to embedded cognitive activities against a control group that lacked engagements of executive functions (EF)

Task	Experimental Group Mean	Control Group Mean
Working Memory	56.07 (SD=2.206)	47.06 (SD=7.631)
Inhibition Control	57.08 (SD=2.209)	46.27 (SD=7.561)
Shifting	56.08 (SD=2.203	45.58 (SD=7.489)

Research Question 3: How effective was reading story with embedded EF activities varied across three months post-intervention period)? Results are indicated in Table 3

Table 3. Descriptive Statistics of EF Activities Scores by Group

Group	N	Mean	SD	SE	95% CI Lower	95% CI Upper	Min	Max
Experimental	3	52.38	0.58	0.33	50.95	53.82	52.04	53.05
Control	3	42.97	1.35	0.78	39.62	46.32	41.58	44.27

Table 3 shows that the experimental group achieved higher average executive function (EF) activities score (M = 52.38, SD = 0.58) than the control group (M = 42.97, SD = 1.35). The difference of about 9.4 points indicates a strong performance advantage for participants who received the reading stories with embedded EF activities during the post-intervention period. The minimum and maximum scores also show a clear separation between the groups, with the experimental group scoring consistently higher than the control group. The variability of scores is lower in the experimental group, suggesting more consistent EF performance among participants exposed to the intervention, while the control group shows greater spread in scores. Additionally, the 95% confidence intervals for the two groups do not overlap, which supports the presence of a meaningful difference between them. Overall, the descriptive results suggest that the intervention is associated with higher and more stable EF outcomes three months after implementation.

Table 4. Test of Homogeneity of Variance (Levene's Test)

Variable	Levene Statistic	df1	df2	p
EF Activities	1.24	1	4	.328

Table 4 presents Levene's test of homogeneity of variance for EF activities scores across the experimental and control groups. The result is not statistically significant, F (1, 4) = 1.24, *p* = .328, which is greater than the .05 threshold. This indicates that there is no evidence of unequal variances between the two groups, meaning the variability of EF scores is comparable across conditions. Therefore, the assumption of homogeneity of variances required for one-way ANOVA is satisfied, and the ANOVA results can be interpreted with confidence.

Table 5. One-Way ANOVA Comparing EF Activities by Group

Source	SS	df	MS	F	p
Between Groups	132.92	1	132.92	123.73	< .001
Within Groups	4.30	4	1.07		
Total	137.21	5			

Table 5 presents the one-way ANOVA results comparing EF activities scores between the experimental and control groups. The analysis shows a statistically significant difference between groups, F (1, 4) = 123.73, *p* < .001. This indicates that the mean EF activities score for the experimental group differs significantly from that of the control group. The large between-groups sum of squares (SS = 132.92) relative to the within-groups sum of squares (SS = 4.30) shows that most of the variation in EF scores is explained by group membership. Overall, the result suggests that the reading stories with embedded EF activities had a significant effect on EF performance during the post-intervention period

Table 6. ANOVA Effect Sizes

Effect Size	Estimate	95% CI Lower	95% CI Upper
Eta Squared	.969	.678	.983
Epsilon Squared	.961	.597	.979
Omega Squared	.953	.553	.975

Table 6 reports the effect size estimates for the difference in EF activities scores between the experimental and control groups. The values for eta squared (η^2 = .969), epsilon squared (ε^2 = .961), and omega squared (ω^2 = .953) are all very large, indicating that the intervention explains the vast majority of the variance in EF scores. In practical terms, this means that group membership (receiving reading stories with embedded EF activities versus control) accounts for about 95–97% of the observed differences in EF performance. The 95% confidence intervals, although wide due to the small sample size, remain high across all measures, reinforcing that the intervention effect is substantial and meaningful.

5. Findings and Recommendations

Overall, the findings indicate that the effect of reading stories with embedded executive function (EF) activities remained strong. Trend towards high performance was observed in the experimental group (108.45) as against the control group (59.05) during the intervention and across the three-month post-intervention period. The experimental group consistently demonstrated higher EF activities scores than those in the control group, and the similarity in group variances confirmed that the comparison was statistically appropriate. The one-way ANOVA showed a significant difference between groups, while the very large effect size estimates, suggest that the sustained differences in EF performance over the three months were largely attributable to the intervention. This implies that the EF-embedded reading activities produced a stable and lasting improvement in executive functioning during the follow-up period. This study therefore provides some evidence for embedding EF activities in preschoolers text reading to promote the efficacy of their working memory, inhibition control and shifting activities. This strengthens findings supporting the enhancement of preschoolers EF's WM (e.g., Diamond and 2011) especially in shifting (e.g., Kray et al. 2012; Röthlisberger et al. 2011; Traverso et al. 2019). Similarly, the data suggest that embedded cognitive activities in individual, as well as group contexts foster preschooler EF's especially in situations of excellent teacher-student interaction.

This is particularly telling when this interaction is characterized by warmth, emotional support, effective organization of learning, cognitive stimulation and creating a positive safe environment. Thus, the findings reported here corroborate Vandell et al., 2010; Ghardashi et al., 2013; Hall et al., 2013; Sylva et al., 2014; Dean and Jayachandran, 2019, all of which confirm the association between EF's development and the environment. The gains in Working Memory, Inhibition Control and Shifting of the experimental group exposed to interacting and playing with peers, and with the teacher in the embedded cognitive reading, might have accounted for the variations in the results. This suggests, that in addition to neurophysiological modulation, development of EF is also susceptible to quality of child-adult relationship. These EF abilities have implications for learning-related abilities- literacy, numeracy, school readiness. For example, gains in Working Memory allowed children in the experimental group to hold sounds in their minds, blended them into words, while inhibition assisted them to stay focused on tasks, such as, letter recognition or listening to a story. Cognitive flexibility assisted them to shift between images presented to them during the intervention phase, as well as their transitioning from play time to structured learning. This strengthens the findings of Blair and Razza (2007) and Bull et al. (2008).

This study may not be exhaustive. It lacked longitudinal dimension. Secondly, it used smaller sample size for purposes of high-precision control, as well as practicality and resource constraints. Even though, small sample allowed for more intense and detailed analysis to increase the validity of our results, it also risks increasing the danger of low statistical power. This notwithstanding, the findings indicated here suggest the efficacy of embedded cognitive activity, effective teacher-child interaction in promoting the development of preschoolers' executive functions. It is being recommended that, further studies be conducted in the study area, using much larger sample size, and a longitudinal approach to compare the findings with this study.

6. Pedagogical Implications

While this study may not be exhaustive, it certainly offers some optimistic support for pedagogical trainability of the three Executive functions of Working Memory, Inhibition Control and Shifting flexibility in a way that could be adopted by teachers and parents. Early preschool teachers and parents could easily embed cognitive challenges to engage children to foster the development of their Executive Functions. Besides, embedding cognitive activity with high quality teacher-child interaction of play, permit EF training to be logically integrated, not only to children's home and kindergarten's condition, but to Early Childhood Education teacher trainees' programme. Given the high-cost of computerized interventions dominating Executive Functions training, accessing the embedded cognitive and high quality of teacher-child approach can be made more readily available to less-advantaged preschoolers EF abilities (Diamond, 2013; Diamond & Lee 2011).

7. Conclusion

Overall, the findings indicate that the effect of reading stories with embedded executive function (EF) activities remained strong across the three-month post-intervention period. Participants in the experimental group consistently demonstrated higher EF activities scores than those in the control group, and the similarity in group variances confirmed that the comparison was statistically appropriate. The one-way ANOVA showed a significant difference between groups, while the very large effect size estimates, suggest that the sustained differences in EF performance over the three months were largely attributable to the intervention. This implies that the EF-embedded reading activities produced a stable and lasting improvement in executive functioning during the follow-up period. Thus, the findings in this study suggest some optimism that pedagogically, preschool teacher trainees and parents, could be trained to foster children's executive functions of Working Memory, Inhibition Control and Shifting flexibility.

Acknowledgement

The author sincerely acknowledges the parents who consented to allow their children to participated in this study. Special thanks also go to the children who so enthusiastically participated in this study.

Funding

None.

Informed Consent

Obtained from parents before testing children. Parents signed a consent form before children were asked to participate in the study. Additionally, the Ethical Board of my institution gave ethical clearance and approval for this study to be conducted

Competing Interests Statement

The author declares no competing or potential conflicts of interest.

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