

The Effects of Executive Functioning Intervention on Students' Reading Achievement in Second
Grade

By Adelaida Nathan

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Abstract

The purpose of this study was to determine the effect of executive functioning intervention on the reading achievement of second graders. This study used a quasi-experimental design which consisted of a pretest and posttest to compare comprehension, accuracy, fluency and number of self-corrections before and after the intervention period. The Fountas and Pinnell Benchmark Assessment System was used to collect data on reading achievement. The interventions used in the study were designed to strengthen students' working memory, attention, and self-regulation. Following the intervention period, students showed significant improvement in the areas of comprehension and number of self-corrections, but not in accuracy or fluency. Future research should continue to explore the possible effects of each type of intervention on reading achievement.

CHAPTER I

INTRODUCTION

Overview

The ability to attend to subject matter, self-regulate and create a plan are essential skills not only to success in the classroom, but also in everyday life. These abilities are related to a set of cognitive skills known as executive function, which includes inhibitory control, working memory and cognitive flexibility. Although students enter the classroom with varying levels of mastery in executive functioning, a vast amount of research supports that students' mastery of executive functioning skills predicts levels of academic success, including grades, SAT scores, and high school completion (Zelazo, Blair, & Willoughby, 2016). Studies also found that children with better executive functioning skills were more adept at retaining information than their peers. Despite these findings, interventions in executive function have not been widely adopted in classrooms.

The increasing need for executive functioning intervention in classrooms can be linked to the growing number of students who have been diagnosed with Attention Deficit Disorder (ADD) and who exhibit ADD symptoms. The current number of children diagnosed with ADD has reached more than 10 percent nationwide (Bluth, 2018). This change marks a significant increase from the 6 percent diagnosis rate in 1997. Underlying deficits in executive functioning skills may be contributing to the higher number of children who exhibit ADD symptoms, such as difficulty completing assignments, prioritizing tasks, staying organized and following sequential directions. The need to focus on executive functioning skills in the classroom is also underscored by the effect poverty has on the cognitive development of a large population of students in the classroom. Several studies have revealed the negative effects of poverty on the development of

executive functioning in the brain. Research by Haft & Hoefft (2018) describes how the pressure of poverty increases levels of stress response hormone present in the prefrontal cortex. Increased levels of cortisol hormone create structural changes to the prefrontal cortex which have a negative impact on executive functioning skills.

The researcher's interest in this topic began from classroom observations and gained depth during a review of research about the effect of poverty on the brain. Through classroom observations the researcher noticed that a portion of students who struggled with reading had similar characteristics; they often had trouble sustaining their attention throughout the task of reading, remembering previous lessons and keeping their ideas and materials organized. Around the same time teachers were introduced to research concerning the effects of poverty on executive functioning through county professional development sessions. The researcher questioned if students weren't achieving success in reading interventions because these cognitive deficits were a barrier that was preventing students from effectively accessing instruction. As a result, the researcher wondered whether building students' executive functioning skills would allow them to engage in reading interventions more effectively.

Statement of Problem

The purpose of this study was to determine if the implementation of classroom interventions targeting executive functioning skills would impact student reading achievement.

Hypothesis

The null hypothesis is that there will be no statistical difference between reading scores on the Fountas and Pinnell Benchmark Assessment before receiving executive functioning intervention as compared to reading scores after executive functioning intervention.

Operational Definitions

Reading Ability. The dependent variable was reading ability. Reading ability was measured by the growth on the Fountas and Pinnell Benchmark Assessment system. Alphabetic levels correspond to cut off scores in accuracy and comprehension. The Fountas and Pinnell Benchmark Assessment system measures accuracy percentage by dividing the number of correctly read words by the number of words in the passage and multiplying by 100. The comprehension score is determined using a rubric score which evaluates student responses to comprehension questions.

Executive Function Intervention. The independent variable was executive function intervention. The teacher will modify the conditions of the class by introducing three executive functioning tasks to students at the beginning of their reading instruction block. The first task, mindfulness meditation, encourages students to use mindfulness techniques to build self-regulation. The second task, spot the difference, seeks to bolster students' attention to detail. The final task, memory game, builds students' working memory.

Chapter II

REVIEW OF THE LITERATURE

Traditionally, reading instruction has focused on building students' skills in several areas including phonemic awareness, phonics, fluency, comprehension and vocabulary. However, an increasing body of research has found that underlying cognitive skills, known as executive function, are essential not only to reading achievement, but also to overall academic performance (Zelazo et al., 2016). This review will examine the role of executive functioning skills, their importance in the development of reading, and evaluate the use of interventions as a method for increasing reading achievement.

Executive Function

Executive function is a broad term that refers to the mental processes needed for complex tasks that require sustained attention, self-regulation, and planning. Although there is still some debate about which skills make up executive functioning, the most widely agreed upon skills are cognitive flexibility, working memory and inhibition. (Zelazo et al., 2016). Cognitive flexibility, also known as shifting, is the ability to disengage attention from one task and focus on another, as well as the ability to consider multiple solutions to a problem. Working memory refers to storing and integrating information in order to perform a task, whereas inhibition is the ability to control attention by ignoring a distraction.

Although executive functioning skills continue to develop into early and mid-adulthood, the most critical years of development occur during early childhood. In fact, the beginning of cognitive flexibility, working memory and inhibition are all present before age 3 (Hughes, 2013). While the processes of executive function have already begun to develop during the toddler years, adolescence working memory, inhibition and shifting become more integrated in order to

perform more complicated tasks. Research has found that the gains in executive functioning during this developmental period are tied to the rapid development of the prefrontal cortex and the growing connections between other parts of the brain (Zelazo et al., 2016). However, much like many other cognitive skills, the development of executive functioning can be shaped by experiential factors such as environmental richness, parenting, and stress.

The study of executive function is especially relevant for educators, not only because of the strong ties to academic success, but also because of the negative effects that poverty and minority status have on its development. Educational research has found that stress associated with limited environmental resources during critical periods of brain development alters the functioning of the prefrontal cortex (Nesbitt, Baker-Ward, & Willoughby, 2013). Children who are exposed to stressful environmental situations, such as poverty or social inequality, have higher levels of stress response hormones that regulate synaptic and neural activity in the prefrontal cortex. This alteration of prefrontal structures leads to negative outcomes in executive functioning (Haft & Hoefl, 2017). Educators have long sought to address the achievement gap between students of high and low socioeconomic status and between majority and minority students. While there have been many initiatives aimed to address the achievement gap, the inclusion of interventions to increase executive functioning skills could be relevant in the future.

Executive Function and its Impact on Reading

Executive function and its cognitive subskills have been found to predict a wide variety of academic markers for success including school readiness in math and reading, overall academic achievement, grades, and high school completion (Zelazo et al., 2016). While executive functioning has also been used to predict later academic success, and conversely, the presence of reading disability, there is still some debate about which aspects of executive

functioning are the most influential.

Educational research indicates that early executive functioning skills present in kindergarten are significant predictors of later academic achievement even several years later. Researchers found that executive functioning deficits in kindergarten, specifically working memory and cognitive flexibility, increased children's risk for reading and mathematics difficulties in first grade (Morgan et al., 2017). Further research found stronger executive functioning skills in kindergarten also predicted "greater reading, mathematics and science achievement as well as fewer externalizing and internalizing problem behaviors in second grade" (p. 8). The study also found that greater inhibitory control was a consistent predictor of academic achievement and classroom behavior, while cognitive flexibility was predictive of academic achievement, but not classroom behavior. Research findings also concluded that strong executive functioning skills in prekindergarten not only predicted greater academic achievement in 5th grade, but also helped to compensate for low levels of academic ability in prekindergarten (Ribner, Willoughby, Blair, & Family Life Project Key Investigators, 2017).

The debate in research about executive functioning skills centers around which aspects of executive functioning are most influential on particular aspects of reading achievement. In a study by Christopher et al. (2012), researchers looked at the effect of working memory, inhibition, processing speed and naming speed on word reading and reading comprehension. The study found that working memory uniquely predicted both word reading and comprehension. However, inhibition did not uniquely predict word reading or reading comprehension. Another study that focused on the link between deficits in executive functioning skills and the predictability of reading disability found that inhibition and working memory, but not cognitive flexibility predicted reading disability (Doyle, Smeaton, Roche, & Boran, 2018). In contrast,

research by Daucourt, Schatschneider, Connor, Al Otaiba, & Hart (2018) found inhibition, working memory and cognitive flexibility all predicted reading disability when using a hybrid model to define reading disability. The hybrid model in the study utilized a composite of four symptoms to define reading disability: low word reading achievement, unexpected low word reading achievement, poorer reading comprehension compared to listening comprehension, and dual-discrepancy response-to-intervention, in addition to the requirement of low achievement and low growth in word reading. The results of the study found that executive function was most likely to predict reading disability when reading disability was defined as having one or more symptoms. While there is still some debate as to the balance of influence from inhibition, working memory and cognitive flexibility, all studies agreed on targeting executive functioning skills as a means for increasing reading achievement.

Review of Interventions

A growing body of research continues to affirm that executive functioning skills such as inhibition, working memory, and cognitive flexibility play an important part in academic success. As a result, research about the effectiveness of interventions has become more prominent. A wide variety of interventions have been successful in increasing targeted aspects of executive functioning; however, not many studies have made clear connections between increased executive functioning from interventions and better academic outcomes (Diamond, 2012). A review of the current research by Diamond (2012) found that while interventions work best for students with the greatest need, in order for executive functioning interventions to be successful they must be challenging and engaging while offering numerous opportunities for practice.

While interventions range from computerized training, school curricula and physical

activity, all interventions include explicit instruction in some aspect of executive function. Computerized training programs such as Cogmed, are computer-based games that target different aspects of executive functioning (Diamond, 2012). Studies found that the use of computer-based games showed significant gains in memory and reasoning but were not effective for inhibitory control. Physical activities, such as traditional Tae Kwon Do and yoga, which incorporated character development, were more successful than physical activities that did not, such as standard physical education. Students in Tae Kwon Do made significant gains in working memory and inhibition, while students in yoga improved in planning and reasoning. Curriculum programs such as Tools of the Mind, Montessori, the Chicago School Readiness Project (CSRP) and Promoting Alternative Thinking Strategies (PATHS) have also been found to be successful executive functioning interventions for children age 3 to 6. Tools of the Mind and the Montessori program have similar features, including a focus on reducing classroom stress, building self-confidence, emphasizing character development as well as academic development, and fostering social skills, oral language, and bonding.

Similarly, integrative body-mind training interventions, which focus on mindfulness, relaxation and mental imagery were found to have an impact on attention, emotional regulation and response to stress in as little as five days (Tang, Yang, Leve, & Harold, 2012). Other studies focused on the effectiveness of executive functioning interventions in a small group setting. Röthlisberger, Neuenschwander, Cimeli, Michel, & Roebbers (2012) found that games such as Simon Says, card sorting, mazes and puzzles, when used in pairs or groups, were found to be effective interventions with 5- and 6-year-olds, showing positive effects on working memory, interference control, and cognitive flexibility.

Summary

Executive function is an essential skill for academic achievement overall but is especially important when considering long term outcomes in reading. Students with greater mastery of executive function skills such as inhibition, working memory and cognitive flexibility are more likely to have better word reading and reading comprehension. Research has shown that growth in executive functioning skills through interventions such as aerobic exercise and mindfulness programs, which build attention and self-regulation, can ultimately lead to better academic achievement.

CHAPTER III

METHODS

The purpose of this study was to determine if executive functioning intervention improves reading performance as measured by the Fountas and Pinnell Benchmark Assessment System, 3rd Edition (F&P BAS).

Design

This study uses a quasi-experimental pretest-posttest design. The pretest and posttest were administered using the F&P BAS. Pretest scores were collected in February of the students' second grade year. Following the treatment, students were reassessed using the Fountas and Pinnell Reading Benchmark assessment in June. The independent variable is participation in executive functioning interventions, and the dependent variable is reading level as determined by the Fountas and Pinnell Reading Benchmark assessment.

Participants

The participants in the study were a convenience sample of 15 second grade students at a suburban public school in Annapolis, Maryland. The demographics of the school are similar to that of the county. Across the school, 28.4% of students are FARMS, and 6.91% of students have limited English proficiency. Within the selected sample of 15 students, 10 were female and 5 were male. The sample consisted of 13 Caucasian students and 2 students from another race or ethnicity. Three students receive services through Individualized Education Plans, English Language Learner plans or are identified as FARMS. All students were reading on grade level at the beginning of the study; however, during the February F&P BAS window, 8 of the 14 students tested at frustration on their current reading level, indicating potentially slow growth in reading.

Instrument

The Fountas and Pinnell Reading Benchmark Assessment System, 3rd Edition, is a formative reading assessment that assesses decoding, fluency, vocabulary, and comprehension in order to determine the reading ability of students from kindergarten to eighth grade. The assessment uses 58 short texts, which are divided into fiction and nonfiction pairs at each alphabetic level. The F&P BAS groups alphabetic levels according to grade level reading expectations. The F&P BAS assesses reading ability by combining reading accuracy percentage and a comprehension rubric score.

The F&P BAS was field tested by the publishing company using 498 students from 22 schools across 6 different states (Fountas & Pinnell, 2012). The sample of students was socioeconomically and ethnically diverse. The field study found the test-retest reliability between the fiction and nonfiction books to be .97 for all books. Researchers also conducted a test of convergent validity using the Reading Recovery Text Level Assessment. The study found correlations of .94 for fiction and .93 for nonfiction when comparing reading accuracy rates with that of the texts used in the Reading Recovery Text Level Assessment.

Procedure

The F&P BAS was administered to all students in February. Students were assigned to reading groups based on their F&P reading level. The six-week executive functioning intervention took place during the first five to ten minutes of the guided reading instructional block. Students were asked to complete one of three different tasks that targeted self-regulation, attention or working memory (Table 1). The mindfulness meditation intervention targeted self-regulation and occurred once a week. Students were asked to complete one of four mental tasks while listening to the sound of a Tibetan bell. During the Deep Breaths Mindfulness task,

students were asked to take slow deep breaths for the duration of the sound of the Tibetan bell. In the Positive thought mindfulness task, students were asked to picture a person and envision telling them a positive message. The Picture a Goal mindfulness task consisted of having students mentally picture accomplishing a goal. During the Happy Place task, students were asked to envision themselves in a place that made them happy. Twice a week, students completed the Spot the Difference task, which focused on building students’ ability to attend to details. Students were asked to view two similar pictures and find 6 differences between the pictures. The Memory task was assigned twice a week and focused on building students’ working memory. For this task students were asked to memorize a set of pictures, words, numbers or letters and recall the items after a few minutes. The number of items in a set increased as the six weeks progressed.

Table 1

Executive Functioning Interventions

Executive Functioning Task	Purpose	Frequency	Brief description
1. Mindfulness Meditation	Self-regulation	Once a week	Students were asked to complete one of four mindfulness tasks while listening to the sound of a Tibetan bell. <ul style="list-style-type: none"> • Deep breaths; students took deep breaths until the sound of the bell stopped. • Positive Thought; students envisioned a positive message and the person they were sending it to. • Picture a goal; students pictured themselves achieving a goal. • Happy place; students picture a place in which they feel happy.
2. Spot the Difference	Attention	Twice a week	Students were asked to circle the differences in two similar pictures. Each picture had six differences.
3. Memory Task	Working memory	Twice a week	Students were given a few minutes to memorize an increasing number of items from a set of pictures, letters, words, or numbers. Then asked to recall the list from memory after a few minutes.

CHAPTER IV

RESULTS

The purpose of this study was to determine if the implementation of classroom interventions targeting executive functioning skills impacts student reading achievement. The null hypothesis was that there would be no statistical difference between reading scores on the Fountas and Pinnell Benchmark Assessment before receiving executive functioning intervention as compared to reading scores after executive functioning intervention. The results of the study showed that the null hypothesis was supported for measures of accuracy and fluency, but rejected for measures of comprehension and self-corrections. The mean pretest score for accuracy was 89.21 (SD = 25.47) and did not significantly increase after the posttest (M = 95.92, SD = 3.27) [$t(13)=-.97, p=.35$] (Figure 1). The mean pretest score for fluency did not significantly increase from 1.92 (SD = .49) to 1.46 (SD = .78) on the posttest [$t(12)=2.14, p=.05$]. However, the mean pretest score for comprehension was 2.69 (SD = 1.25) and did significantly increase after the posttest (Mean = 4.46, SD = 1.20) [$t(12)=-4.90, p<.05$]. The mean pretest score for self-corrections also significantly increased from .80 (SD = 1.03) to 3.80 (SD = 3.36) on the posttest [$t(9)=-2.79, p<.05$] (Figure 2).

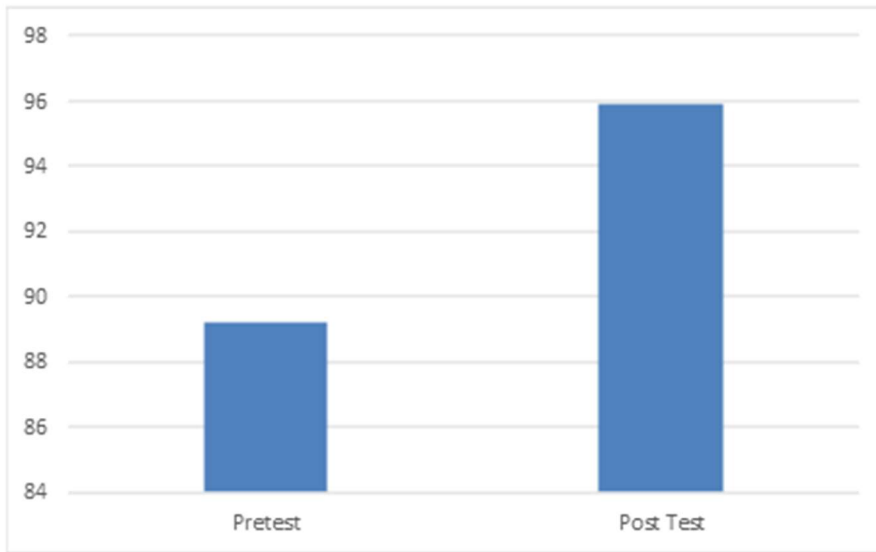


Figure 1. Fountas and Pinnell Pre and Posttest Scores for Accuracy

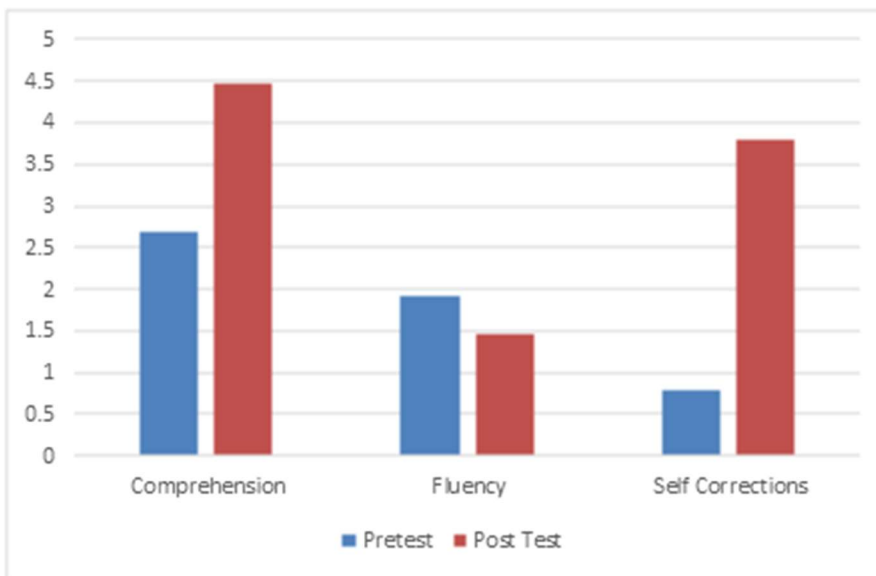


Figure 2. Fountas and Pinnell Pre and Posttest Scores for Comprehension, Fluency and Self-Corrections

CHAPTER V

DISCUSSION

The purpose of this study was to determine if the implementation of classroom interventions targeting executive functioning skills impacts student reading achievement as determined by the Fountas and Pinnell Benchmark Assessment. The null hypothesis was that there would be no statistical difference between reading scores on the Fountas and Pinnell Benchmark Assessment before receiving executive functioning interventions as compared to reading scores after executive functioning intervention. The results of the study showed that the null hypothesis was supported for measures of accuracy and fluency, but rejected for measures of comprehension and self-corrections.

Implications of Results

The results of this study indicate that executive functioning interventions in the classroom improved some, but not all aspects of reading achievement. Using the Fountas and Pinnell Benchmark Assessment for the pre and post assessment, data was collected that assessed students' reading accuracy, comprehension, and fluency, as well as the number of self-corrections students made while reading.

Significant student improvement was seen in the areas of reading comprehension and number of self-corrections. During the Fountas and Pinnell Benchmark assessment, reading comprehension is measured by rating student responses to comprehension questions using a 6-point or 9-point rubric, depending on the level of book used in the assessment. After the intervention, the mean comprehension score increased significantly from 2.69 to 4.46. Similarly, self-corrections are measured by assessing the number of reading errors students self-correct without prompting. Student achievement in this area also significantly increased from a mean

score of .8 to 3.8.

While some measures of reading achievement showed significant improvement, reading accuracy and fluency did not show significant improvement. Reading accuracy is measured on the Fountas and Pinnell Benchmark assessment by determining the percentage of correctly read words in the passage. While the mean score improved from 89.21 to 95.93, the increase was not significant. Surprisingly after the intervention, the mean score for reading fluency decreased from 1.92. to 1.46. However, this decrease was not significant. The Fountas and Pinnell Benchmark assessment uses a 3-point rubric to assess reading fluency. The data collected from this study showed that executive functioning interventions significantly increases reading comprehension and self-corrections during reading.

Theoretical Consequences

The results of this study partially support two key findings addressed in a review of current research by Zelazo et al. (2016). In the review, the researchers concluded that executive functioning skills are malleable and can be influenced positively or negatively by life experiences. They also stated that childhood executive functioning skills are an essential foundation to learning across several contexts. During this study, participants took part in executive functioning interventions which were designed to strengthen attention, working memory and self-regulation. This intervention resulted in significant improvement in the areas of reading comprehension and self-correction. These results support current theories that executive functioning skills can be influenced by positive life experiences, such as intervention, and that improving executive functioning skills leads to better academic outcomes, such as greater reading achievement. However, this study did not find that the intervention had a significant effect on reading accuracy or fluency. This aspect of the results does not support the findings by

Zelazo et al. (2016).

Threats to Validity

During the study, several threats to internal and external validity were present and could have influenced the results. For instance, the sample of participants was relatively small, lacked diversity and was collected using a convenience sample. Participants in the study were from the same class, and the majority of students used in the sample were Caucasian, reading on grade level, and were not from different socio-economic backgrounds. The lack of diversity in the sample may make the results harder to generalize to more diverse student populations.

Additionally, all students in the sample were between seven and eight years old, and as a result the interventions used in this study may not be generalizable to older or younger students.

The pretest and posttest design of the study also contain several threats to validity. While the Fountas and Pinnell Benchmark assessment pretest and posttest are administered and measured similarly, in order to measure growth, the text used to administer the assessment during the posttest was more challenging than the text used in the pretest. The administration of the initial pretest was also collected from a single test as opposed to a collection of data over time. As a result, the pretest scores may not reflect typical reading ability for each student. Additionally, students' natural maturation during the intervention period may have contributed to their reading growth instead of reading growth being a result of the intervention.

Connections to Literature

A similar study by Christopher et al. (2012) sought to explore the predictability of executive functioning skills, such as working memory, inhibition, processing speed and naming speed, in determining individual differences in word reading and reading comprehension. Researchers from the study collected executive functioning data using several tests and

compared the data to reading scores on four reading comprehension assessments and three word reading assessments. The study found that working memory and general processing speed were unique predictors of reading comprehension and word reading.

In the current study, working memory interventions were used to determine the effect on reading scores as measured by the Fountas and Pinnell Benchmark assessment. While the methods and assessments used during the studies differ, both studies found that working memory played an important part in comprehension. The current study showed that executive functioning intervention significantly increased reading comprehension; however, contrary to the study by Christopher et al. (2012), the results of this study showed the executive functioning intervention did not have a significant effect on accuracy or word reading.

Implications to Further Research

Based upon the results of this study future research would be beneficial in developing several areas for improvement in this study. The sample population of the current study was relatively small and homogenous. Repeating the study with a larger, more diverse population would allow researchers to make conclusions that are more relevant to the larger population. The study also used three separate interventions. While the interventions did result in significant growth, it is unclear how each intervention contributed to reading growth. Duplicating the study with each intervention separately would allow researchers to determine the effectiveness of each intervention. Variations in the way the intervention was administered also warrant further research. The current study conducted the intervention in a whole group classroom setting and took place for a brief period of time. Repeating the study with longer periods of intervention and carrying out the intervention in small group or with individuals would also help researchers determine the scope of the intervention's effectiveness.

Summary

In review, the use of executive functioning interventions in a classroom setting has a significant impact on reading comprehension and self-correction; however, it did not significantly increase reading accuracy and fluency. The results of the study suggest that simple executive functioning interventions that focus on building students' working memory, attention and self-regulation can significantly increase aspects of reading achievement. The interventions used in the study were quick and easy to incorporate into daily lessons and were engaging for students. By incorporating these quick interventions, teachers can build students' executive function skills, which not only positively influence their reading ability, but also lead to a wealth of other positive long term academic outcomes.

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