ABSTRACT

Title of Dissertation:	INTERVENTIONS TARGETING THE EXECUTIVE FUNCTION SKILLS OF YOUNG CHILDREN
	Jennifer Marie McCatharn, Doctor of Philosophy, 2021
Dissertation directed by:	Dr. Ana Taboada Barber, Counseling, Higher Education, and Special Education

Interest in improving children's executive function (EF) skills through interventions is increasing and several approaches have been tested (Takacs & Kassai, 2019). However, there is a need to further focus on specific populations of students, such as young students. The focus on young children (under age 7) in the synthesis and in the subsequent intervention studies is important as there is evidence that EF development has specific theoretical and empirical groundings to consider for this age group.

Chapter 2 of this dissertation is a synthesis of mindfulness-based interventions targeting the EF skills of young children. The synthesis examines nine studies and provides in-depth descriptions of the interventions, ratings of the methodological rigor, and reports the effects of interventions.

Chapter 3 reports the findings from a randomized control trial of two intervention approaches: mindfulness and social-emotional learning (SEL) conducted in small groups. Chapter 4 describes a second study which explores the effects of implementing a novel

intervention (Mindfulness + SEL) to whole classrooms of students in kindergarten compared to a historical control group from the first study. Although the outcomes of most omnibus tests performed were non-significant in both studies, inspection of the effect sizes seemed to demonstrate a pattern of EF skill improvement favoring students in the intervention conditions over control group students. Both studies occurred in a public school in a typically under-resourced community, thus the findings are likely be relevant to schools with similar demographic profiles.

This dissertation contributes to the field in the following ways: the synthesis provides a specific focus on EF skill development and interventions for children under age 7, Study 1 provides a comparison of two EF intervention approaches which have not been directly compared, and Study 2 provides preliminary data on the implementation of a combined, practitioner informed intervention. Both studies utilize an EF measure which has strong psychometric properties and matches the age appropriate construct of EF. The effects reported in both studies will likely contribute to future meta-analyses of EF interventions, as well as to the planning of future interventions. Areas for future research are discussed throughout the dissertation.

INTERVENTIONS TARGETING THE EXECUTIVE FUNCTION SKILLS OF YOUNG CHILDREN

By

Jennifer McCatharn

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Advisory Committee:
Associate Professor Ana Taboada Barber, Chair
Assistant Professor Lucas Butler
Associate Professor Kelli Cummings
Professor Laura Stapleton
Associate Professor Jade Wexler

Dedication

To my Mom, you’ve always made it clear that you believed my life was a much-waited-for miracle and that I had a purpose for being here, I love you.

And to God, I heard you say, “my grace is sufficient for you” and it has made all the difference.

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Chapter 1: Introduction

This proposed dissertation manuscript will examine executive function (EF) skills and interventions which are designed to increase the EF skills of young children. EF skills are considered the building blocks of learning as they underlie goal-directed behavior and provide students with the tools to manage impulsivity and make choices which facilitate reaching goals or achieving desired outcomes (Griffin et al., 2016). EF skills have been measured and grouped into three interrelated, yet distinct skill groups: cognitive flexibility (sometimes referred to as "shifting"), inhibitory control, and working memory (sometimes referred to as "updating"; Miyake et al., 2000; Center on the Developing Child at Harvard University, 2011; Brydges, Reid, Fox, & Anderson, 2012; Miyake & Friedman, 2012; Griffin et al., 2016; Zelazo et. al, 2017). *Cognitive flexibility* involves the mental task of switching between concepts (Zelazo et al., 2016). The second component of EF skills, *inhibitory control*, involves suppressing distraction and maintaining attention on a specific object or task (Zelazo et al., 2016). Inhibitory control is also sometimes labeled "inhibition" and is defined as "controlling one's attention, behavior, thoughts and/or emotions to override a strong internal predisposition or external lure" (Diamond, 2013). The third component, *working memory*, is defined as "holding information in mind and mentally working with it (e.g., relating one thing to another, using information to solve a problem; Diamond, 2013). These skills coordinate and work together to support learning and well-being throughout childhood and into later life (Griffin et al., 2016).

EF skills are important for lifelong success and are associated with specific outcomes of interest to practitioners, policymakers, and researchers who are interested in the well-being of children. A student's EF skills in early childhood can be highly predictive of EF skills in adolescence and adulthood and evidence is accumulating which indicates that trying to improve EF skills in the early years may be the most crucial and promising time to intervene (Griffin et al., 2016). Executive function skills in kindergarten have been found to predict academic achievement in math, reading, spelling and writing at the end of first grade (Monette et al., 2011; Vandenbroucke, et al., 2017). A positive relation between EF skill development, prosocial behavior, and school performance has also been documented (Motamedi, et al., 2016; Zorza et al., 2016). This correlational research has provided insight and provoked interest in examining how EF skills intersect with academic and behavioral outcomes and it has caused many to wonder if EF is responsive to intervention.

The positive associations with EF skills and school readiness, as well as other important outcomes for children, have led to a variety of EF interventions being identified as effective, including but not limited to: computerized training, aerobic exercise, martial arts, mindfulness, classroom curricula, and Montessori instruction (e.g., Diamond & Lee, 2011) In a recent meta-analysis of EF interventions, an overall a positive effect was found across all studies (g=.30; Takacs & Kassai, 2019). From this comprehensive meta-analysis, "providing new strategies of self-regulation" emerged as the category with the largest overall effect size and included the following subcategories: mindfulness practices (g=.46), biofeedback-enhanced relaxation (g= .93), and strategy teaching interventions (g=.30). "Strategy teaching" interventions were described by the authors a sub-category of interventions which overtly taught strategies of self-regulation (Takacs & Kassai, 2019). This research provides encouraging evidence that EF skills are malleable and that interventions which target EF skills have the potential to improve short-term and long-term life trajectories of students. While the meta-analysis provides information across categories of interventions and reported effects, a deeper dive into the intervention approaches within the umbrella category highlighted ("providing new strategies of self-regulation") is warranted. While providing new strategies of self-regulation demonstrated the largest effect size, only five of the 20 included studies within this intervention category focused on participants under the age of 7 and further demographic information (race/ethnicity, socioeconomic status) was not included nor discussed, additionally the characteristics of the interventions were not explored in depth. The findings from Takacs & Kassai (2019) provide support for the continued investigation of EF interventions and how they may best be implemented (curriculum, dosage, setting) with diverse student populations (age, race/ethnicity, geographic location, socioeconomic status). This dissertation contributes to the field and is distinct from prior work in the following ways: the synthesis provides a specific focus on EF skill development and interventions for children under age 7, Study 1 includes a randomized-control comparison of two EF intervention approaches, and Study 2 provides preliminary data on the implementation of an innovative, practitioner informed EF intervention conducted whole group. Both studies utilize an EF measure which has strong psychometric properties and matches the age appropriate construct of EF. Thus it is hypothesized that the studies will contribute to future meta-analysis of EF interventions as well as to the planning and implementation of future EF intervention studies.

Outline of Proposed Dissertation Manuscript

The present chapter (Chapter 1) introduces the problem of the increased interest in EF skills but the proportionally limited understanding of which intervention approaches are best suited for specific groups of students, as well as which features of interventions are most efficacious in improving the EF skills for young children. Chapter 2 is a synthesis of mindfulness-based interventions for young children (less than 7 years old) which target EF skills. Two research questions are answered in the synthesis: “What are the characteristics of mindfulness-based interventions which target young children’s executive function skills?” and “What are the effects of mindfulness-based interventions on the executive function skills of young children?” The specific focus on young children (under 7 years old) in the synthesis and in the subsequent intervention studies is important as there is evidence that EF development is occurring most rapidly from age 3 to 6 years old and is likely most accurately measured as a unitary construct at this age, as the three domains (cognitive flexibility, inhibitory control, working memory) are working in ways that are so closely overlapping it is hard to distinguish each. If indeed, EF is best measured differently across the lifespan, it is worth exploring whether the intervention approaches used may need to vary across the lifespan. While a 5 year old and an 8 year old are “close” in age, in the realm of EF skill development and subsequent measurement they may be vastly different, thus it is important to group examination of interventions and approaches by age to possibly glean more fine grain understanding of what is most effective with unique age groups and student populations. The synthesis (Chapter 2) provides insight into the features of mindfulness-based interventions being used with young children as well as an examination of the various EF and EF-related measures being used in research, highlighting the complexity in interpreting findings of EF interventions when multiple measures are used which can vary in methodological quality and in the reporting of results (e.g., scoring accuracy and speed separately, reporting scores of different trials of the same task). Of the nine mindfulness-based interventions included in the synthesis, only five were eligible to meet the WWC standards. There is necessity in replicating findings of prior studies using rigorous experimental methodology when examining EF interventions as well as seeking to compare approaches on specific populations of students.

In Chapters 3 and 4, respectively, I describe two studies of EF interventions. Chapter 3 is an intervention study (Study 1) that builds upon the findings of the Chapter 2 synthesis of mindfulness-based interventions targeting EF skills. The intervention study is a randomized control trial in a school setting with 91 kindergarten students, which compares two EF intervention approaches: social-emotional learning and mindfulness-based to a control group. Study 1 seeks to answer two research questions: "Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on EF skills over time, immediately following the intervention (T1 to T2)?" and "Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on academic achievement (math and reading) and EF skills over time, at end of year testing (T1 to T3)?" These findings inform future EF interventions by providing a comparison of two intervention approaches, social-emotional learning (SEL) and mindfulness-based. The results of Study 1 provide insights into the benefits and limitations of conducting a short-term, small group EF intervention. The experience of conducting the interventions in Study 1 led to "practitioner" level insights and as the interventionist and researcher, I noticed trends in student engagement with the content, thus subsequently informing decisions about developing a hybrid approach which is explored in Study 2.

Chapter 4 includes a second study (Study 2) which seeks to add to the field by testing the efficacy of a novel EF intervention approach (Mindfulness + SEL) which combines what I hypothesize are the strongest components of a mindfulness-based intervention with the strongest components of a SEL intervention. The approaches are theorized to be complementary (Lawlor, 2016), and this novel intervention seeks to leverage the respective strengths of each. In Study 2, the effects of this novel intervention approach are tested against a historical cohort control group (from Study 1). The research questions for Study 2 were as follows: "Is there a significant difference between groups (Mindfulness + SEL intervention and control) on EF skills over time (T1 to T2) and (T1 to T3)?" and "Is there a significant difference between groups (Mindfulness + SEL intervention and control) on academic achievement (math and reading) over time, at end of year testing (T1 to T3)?" As is highlighted in the synthesis, EF intervention studies have varied in the measures used and the alignment the measures have with actual EF skills, with some studies using measures that align with constructs such as "self-regulation" or "temperament" rather than EF skills alone. The Minnesota Executive Function Scales (MEFS) is used in both Study 1 and Study 2. The MEFS is an EF measure with strong psychometric properties and alignment with the unitary construct of EF, which is most appropriate for the age group in both studies. The studies in this dissertation add to the literature by using a rigorous, randomized design in Study 1 and a quasi-experimental design in Study 2 to pilot an innovative program. Additionally, both study designs included plans to assess fidelity of implementation via video recordings, providing important information about the degree to which each study was implemented according to plan.

Across all three papers (synthesis, Study 1 and Study 2), I seek to explore the effects of EF interventions on young children. The synthesis provides a snapshot of mindfulness-based interventions for a specific age range of students and is likely to be relevant reading for both researchers and practitioners interested in EF interventions for young children. Study 1 and 2 provide insight into the efficacy of short-term interventions which target EF skills. The school setting in both studies is a school which is located in an under-resourced community. The findings of the studies may inform future intervention programming which can increase student EF skills and potentially mitigate the challenges of experiencing poverty or other adversities.

Definition of Key Terms

Cognitive Flexibility: involves the mental task of switching between concepts, such as a student reading a compound word as a whole-word (e.g., “butterfly”) while also recognizing the individual words within the word (e.g., “butter” and “fly”; Zelazo et al., 2016). Diamond (2013) defines cognitive flexibility as “changing perspectives or approaches to a problem flexibility adjusting to new demands, rules, or priorities (as in switching between tasks).”

Executive Function Skills (EF): skills that underlie goal-directed behavior and provide students with the tools to manage impulsivity and make choices which facilitate reaching a goal or achieving a desired outcome (Griffin, McCardle, & Freund, 2016); The three domains of EF skills are distinguishable but coordinate very closely, and are often described as cognitive flexibility, working memory, and inhibitory control (Center on the Developing Child at Harvard University, 2011; Diamond, 2013; Zelazo et al., 2016).

Inhibitory Control: suppressing distraction and maintaining attention on a specific object or task (Zelazo et al., 2016). Inhibitory control is also sometimes labeled “inhibition” and is defined as “controlling one’s attention, behavior, thoughts and/or emotions to override a strong internal predisposition or external lure” (Diamond, 2013).

Meditation: can be described as mental training that targets a person’s psychological capacities such as self-regulation of attention and emotion (Tang, Hölzel, & Posner, 2015). Meditation is considered a core element of mindfulness practice and is to be trained and developed in the context of MBIs (e.g., Crane et al., 2017).

Mindfulness: One proposed operational definition of mindfulness practice involves a two-component model, the first component of the model includes the self-regulation of attention on the present moment, the second component involves taking on a particular orientation or attitude toward one's experiences in the present moment, this mindful orientation is described as that of "curiosity, openness, and acceptance" (Bishop et al., 2004). The first component, "self-regulation of attention on the present moment," requires "skills in sustained attention" and the second, a mindful orientation, involves a commitment to "maintain an attitude of curiosity about where the mind wanders" (Bishop et al., 2004).

Social-emotional learning (SEL): "the processes of developing social and emotional competencies in children" and this learning can occur through direct social and emotional skills instruction and practice as well as engagement in practices that foster positive interactions and relationships between students and teachers (Collaborative for Academic, Social, and Emotional Learning, 2013).

Working Memory: storing information and manipulating it, as is experienced when bringing together sections of a reading passage to achieve comprehension of the whole (Zelazo et al., 2016). Working memory is defined as "holding information in mind and mentally working with it (e.g., relating one thing to another, using information to solve a problem; Diamond, 2013)

Chapter 2: Research Synthesis

A growing trend in the field of educational research is to consider and evaluate the role executive function skills play in student academic achievement, social-emotional success, and students' long-term outcomes (Diamond & Ling, 2016; Zelazo, Blair, & Willoughby, 2017). Executive Function (EF) skills are a "family" of neurocognitive skills that are utilized by persons of any age when concentrating, making decisions, and managing impulses and are highly dependent on neural circuitry in regions of the prefrontal cortex (Diamond, 2016). EF skills are considered building blocks of learning as they underlie goal-directed behavior and provide an individual with the tools to manage impulsivity and make choices which facilitate reaching a goal or achieving a desired outcome (Griffin et al., 2016). EF skills have been described conceptually as the "air traffic control system" of the brain, where information is sorted and decision making is often rapidly occurring, similar to the ongoing "arrivals and departures" of planes at an airport (Center on the Developing Child at Harvard University, 2011). EF skills have been measured and subsequently grouped into three interrelated, yet distinct skill groups: working memory (sometimes referred to as "updating"), cognitive flexibility (sometimes referred to as "shifting"), and inhibitory control (Miyake et al., 2000; Center on the Developing Child at Harvard University, 2011; Brydges et al., 2012; Miyake & Friedman, 2012; Griffin et al., 2016; Zelazo et. al, 2017). EF skills are distinct but related to intelligence and Rueda et al. (2012) states that, "transfer to intelligence after training of executive functions is relatively unsurprising given the interrelated nature of EFs processes and the fact that many common regions of the frontal lobe are recruited by cognitive demands involved in general intelligence and the various processed under the umbrella of EFs (Duncan and Owen, 2000)" (p.193). Another reason EF skills and subsequent interventions continue to be of interest to researchers and practitioners is the evidence base that students with low or poor initial EF skills (e.g., students who are lower-income, children with ADHD) generally demonstrate the most improvement in EF skills from intervention programming, thus EF interventions may be an avenue to "level the playing field" for all students and reduce the achievement gap (Diamond & Lee, 2011).

The Relationship between Age, EF Development, and Construct

It is important to understand the relationship between age, executive function development and the subsequent pairing with EF constructs. This section will provide an overview of what has been documented in the field concerning the possible differences in EF skill development and measurement across the lifespan. Latent variable analysis has been readily utilized to determine if EF skill groupings (i.e. cognitive flexibility, inhibitory control, and working memory) are distinct and should be measured using a one, two, or three factor model; the findings of these analyses will be discussed below.

In Miyake et al.'s, seminal paper, the "unity and diversity" framework was born (2000). In this study, the authors intended to specify the degree to which three executive functions (inhibition, shifting, updating) were "unitary" or "separable" using a sample of young adult participants (Miyake et al., 2000). Using confirmatory factor analysis, they concluded that the three targeted executive function domains (inhibition, shifting, updating) showed both "unity" and "some underlying commonality" with shifting, updating and inhibition being distinct enough to support a three-factor model of EF skills. After Miyake et al.'s publication of their findings in 2000, researchers attempted to test this three-factor model (inhibition, shifting, updating) with different age groups to assess if the three-factor model fit data with study participants at younger ages as well. Further research has indicated that when EF skills are measured in young children they do not match a three factor model and instead fit best with a one factor model, indicating that a unitary construct of EF is most accurate to describe EF at younger ages (e.g., Brydges et al, 2012).

In examining the specific age ranges of young children and their corresponding EF skill development, it has been suggested that EF is not suitably measurable from birth to two-years old and thus most studies of EF do not extend younger than age three (Jones, S. M. et al., 2016) . Children three to five or six-years old are often described as "preschool children" (in the United States educational context, six is the in which age students complete kindergarten and enter first grade), and "school-aged children" are children age seven and older. In a study exclusively examining a sample of three-year olds' EF skills, a single latent EF construct was found to be the best fit (Wiebe et al., 2011). Similarly, in studies of children ranging in age from three to six, a unitary construct has been identified as the best fit (Hughes et al., 2009; Shing et al., 2010; Wiebe et al., 2007; Willoughby et al., 2012). It is hypothesized that the distinctions among EF domains begin to crystalize and are more distinctly measurable as students exit preschool contexts and advance to elementary and middle school (e.g., Shing et al., 2010).

School-aged children are considered distinct from "preschool children" and usually range in age from age seven to 16 (where the category of "adolescents" then emerges). While relatively consistent agreement about a one factor or unitary model has been identified for children six and under, agreement around the most appropriate construct for older children has been disputed (e.g., Demetriou & Spanoudis, 2015). As children age toward adulthood, a shift occurs which may vary due to individual differences and has resulted in one, two and three factor models being fitted for this age group. In one study of seven to nine-year olds a one-factor model was described as the best fitting model for the eight-year olds and a two factor model (working memory, shifting/inhibition) was the best fitting for the EF performance of 10 year olds (Brydges et al., 2014), however this study was remodeled in a critique paper which asserted that the models used by Brydges et al. (2014) were incomplete (Demetriou & Spanoudis, 2015). In a study of 11 to 12-year olds, a three-factor model (inhibition, shifting, updating) was found to be the best fit matching the model matched with adults and adolescents (Duan et al., 2010). These studies of school-age or middle-age children highlight the complexity of pinpointing a shift from unitary to multi-factor (two or three factor) models as children's EF skills are changing to include increasingly automated inhibitory control, more efficient cognitive flexibility, and improved working memory during these years (Demetriou & Spanoudis, 2015).

In a recent re-analysis of latent variable studies involving executive function skills, the authors concluded that most published measurement models use a one to two-factor model among preschoolers, while a three factor (inhibition, shifting, updating/working memory) model is most common among school-aged children, adolescents, and adults (Karr et al., 2018). This body of research highlights the complexity of EF development and the necessity of considering the age of study participants when analyzing findings and making determinations about how to compare and interpret data across studies.

EF and Academic Achievement

Interest in understanding executive function skills has continued to build as meta-analyses have documented the predictive relationship between EF skills and academic achievement and school readiness (e.g., Cortés Pascual et al., 2019). Positive associations between EF skills and emergent literacy skills have been found beginning in preschool students when controlling for language status, gender, age, and maternal education (Becker et al., 2014). In a meta-analytic review of the relation between EF skills and reading comprehension, a consistent and positive association was found across the age range of six to 17-year-old participants (Follmer, 2018). Research has also highlighted the contribution of EF skills as they are distinct from IQ in predicting school adjustment (Masten et al., 2012). Deficits in kindergarten students' EF skills have been found to increase student risk for academic challenges across elementary school (e.g., Morgan et al., 2019). When these positive and longitudinal associations between EF skills and school success are reported in empirical research, often a call is made to focus on EF skills directly as a worthwhile target of intervention (Willoughby, Wylie, & Little, 2019).

Interventions Targeting EF

In light of the documented positive associations between academic achievement and EF skills, several papers and a recent meta-analysis have been written summarizing and synthesizing the myriad of strategies and interventions being explored to improve the executive function skills of children (e.g., Diamond & Ling, 2016; Takacs & Kassai, 2019). Categories of interventions have emerged and in one recent meta-analysis of interventions targeting EF skills the studies were coded and organized by the following intervention types: explicit practice (computer and non-computer training), physical activity, EF-specific curricula, art activities, and providing new strategies of self-regulation (mindfulness practice, biofeedback- enhanced relaxation, strategy teaching interventions; Takacs & Kassai, 2019). Overall a positive effect was found across all intervention studies (g=.30) and effects ranged in the categories of interventions from .12 to .46. The specific effect sizes by intervention category were as follows: explicit practice (*g*=.38), physical activity (*g*=.16), EF-specific curricula (*g*=.12), Art activities (*g*= .07), and providing new strategies of self-regulation (*g*=.46; Takacs & Kassai, 2019). From this comprehensive meta-analysis, "providing new strategies of self-regulation" emerged as the category with the largest overall effect size and included the intervention subcategories of mindfulness practices (*g*=.46), biofeedback-enhanced relaxation (*g*= .93), and strategy teaching interventions (*g*=.30). While biofeedback-enhanced relaxation demonstrated a large effect size, the authors of the meta-analysis concluded the paper by discussing the likely higher expenses of biofeedback techniques and emphasized the possible cost effectiveness of further studying mindfulness practices as they are cost effective and can be made accessible to large groups of students (Takacs & Kassai, 2019).

What is Mindfulness?

As documented in the Takacs & Kassai (2019) meta-analysis, a promising executive function intervention strategy may be the use of mindfulness-based interventions (MBIs). "Mindfulness" as a construct and a topic of research in psychology has been described as generally having three meanings present in the literature: "1) a mental trait; 2) a soteriological or spiritual path conceived in therapeutic and health-promotion terms; and 3) a single cognitive process commonly trained across multiple human activities" (Lutz et al., 2015). With this multi-component definition put forth, we are left to consider: is mindfulness a trait, a way of life or attitude ("soteriological or spiritual path"), a cognitive process, or some combination of all three? One proposed operational definition of mindfulness practice involves a two-component model, the first component of the model includes the self-regulation of attention on the present moment, the second component involves taking on a particular orientation or attitude toward one's experiences in the present moment, this mindful orientation is described as that of "curiosity, openness, and acceptance" (Bishop et al., 2004). The first component, "self-regulation of attention on the present moment," requires "skills in sustained attention" and the second, a mindful orientation, involves a commitment to "maintain an attitude of curiosity about where the mind wanders" (Bishop et al., 2004). "Meditation" can be described as mental training that targets a person's psychological capacities such as self-regulation of attention and emotion (Tang et al., 2015). Meditation is considered a core element of mindfulness practice and is to be trained and developed in the context of MBIs (e.g., Crane et al., 2017).

Multiple theoretical frameworks which describe the mechanisms underlying mindfulness meditation have been cited in the field (Hölzel et al., 2011). Kabat-Zinn (1994) described mindfulness as "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (p.4). Shapiro et al. (2006) built upon the Kabat-Zinn (1994) definition and developed a mindfulness framework comprised of three axioms: attention, intention, and attitude. These three axioms of mindfulness are described not as separate stages but as an ongoing process, thus conceptualizing mindfulness as a "moment-to-moment" process which engages these three axioms (intention, attention, attitude) simultaneously (Shapiro et al., 2006). The axioms are considered fundamental components of mindfulness practice and are hypothesized to account directly or indirectly for variance in the changes observed after engaging in mindfulness practice; subsequently it is suggested in this theoretical framework that intention, attention, and attitude lead to a significant shift in perspective called "reperceiving" (Shapiro et al., 2006). Reperceiving is considered a meta-mechanism which "overarches" additional direct mechanisms of change, such as: (1) self-regulation, (2) values clarification, (3) cognitive, emotional, and behavioral flexibility, and (4) exposure. These mechanisms, influenced by the meta-mechanism of reperceiving via mindfulness in the Shapiro et al. (2006) framework, are directly aligned with EF skill (cognitive flexibility, inhibitory control, working memory) development. Thus the Shapiro et al. (2006) framework provides a theoretical grounding to explain how mindfulness practices which engage the participant's attention, intention, and attitude, ultimately lead to a change in perspective (meta-mechanism: reperceiving) which subsequently enhances other direct mechanisms, such as executive function skills.

Mindfulness and EF

Research is indicating that mindfulness may cause neuroplastic changes in the brain regions which are specifically involved in the regulation of attention, self-awareness, and emotional awareness, if these findings continue to emerge, the use of mindfulness could be a promising intervention to support mental and physical health (Tang et al., 2015).

Mindfulness and mindfulness-based meditation may improve EF skills by both addressing attitude and affect of persons completing tasks as well as improve brain functioning such that actual execution of tasks is improved. In a paper exploring the mechanism linking executive control and meditation and mindfulness, the authors found that meditation practice in the context of mindfulness-based interventions related to greater executive control and was explained by increased emotional acceptance and "brain-based performance monitoring" (Teper & Inzlicht, 2013). Put simply, they found that meditation improved executive function skills and they accounted for this change by observing an increase in acceptance of emotional states (the “attitude” component previously describing mindfulness) as well as the participants improved control which they associated with the mindfulness practice (Teper & Inzlicht, 2013).

The Present Study

The purpose of this synthesis is to review the existing empirical literature documenting the implementation of mindfulness-based interventions which have targeted young children’s executive function skills. Two research questions which are explored in this synthesis: “What are the characteristics of mindfulness-based interventions which target young children’s executive function skills?” and “What are the effects of mindfulness-based interventions on the executive function skills of young children?”

Method

The search for empirical, peer reviewed articles to comprise this synthesis followed the sequence outlined by Cooper and Hedges (2009) in their introductory chapter in *The Handbook of Research Synthesis and Meta-Analysis* (Cooper, Hedges, & Valentine, 2009). The subsequent sections will follow the Cooper and Hedges’ (2009) guidance and will provide a detailed description of the process for each step, in the following order: problem formation, literature search, data evaluation, data analysis, interpretation of results.

Stages of Research Synthesis

Problem Formation. The introductory literature review presented highlighted the growing interest in executive function skills and subsequent interventions. The literature highlights the early childhood years as a key window for EF growth and development. While reviews of possible avenues to improve EF have been published (Diamond & Ling, 2016), a synthesis of mindfulness-based intervention studies which have targeted students in the early childhood age range, where a unitary construct of EF may be most appropriate, has yet to be published.

Literature Search. To answer my research questions, I used the following search terms: DE "Executive Function" AND (mindfulness or mindful or mindfulness-based or meditation) AND (kindergarten OR preschool OR early childhood education OR elementary education OR children) AND (AND Intervention Or DE "School Based Intervention" OR DE "Group Intervention" OR DE "Early Intervention"). This search was conducted in EBSCO and included the following databases: Academic Search Ultimate, Education Source, ERIC, Primary Search, Psychology and Behavioral Sciences Collection, and PsycINFO. The search returned 33 articles written in English, published between 1997 and 2019, with no limit set on the year of publication during the search process (see Figure 2.1, Appendix A). The screening criteria used were as follows:

1. Published in a peer-reviewed journal and accessible in English
2. Participants included in the intervention were under the age of 7
3. Interventions were “mindfulness” based (as described by the authors)
4. Interventions were utilized which specifically targeted executive function skills as an outcome variable (as described by the authors)

In the initial screening process of the 33 returned articles, reviews, meta-analyses, chapters and correlational studies were excluded (n=14), dissertation studies (n= 6), and a pilot study which lacked outcome data was also excluded (n=1). After this initial screening, the secondary exclusion criteria focused on the study population. Articles were selected which included preschool, school age, and elementary age students between 0-6 years old. This age range has been suggested as a critical period for intervention while students’ brains may be most malleable to change (Griffin et al., 2016). Studies which included students over the age of 7 or had mixed age groups including students over the age of 7 were excluded (n=6).

Two recent meta-analyses were found during the search (Dunning et al, 2019; Takacs & Kassai, 2019) and an ancestral search was conducted of the included articles in both papers. This led to the inclusion of one additional empirical study which had not been returned in the initial search (n=1). In the fall of 2019, after the official search window had closed for the writing of this paper, the first author of this synthesis located an article while investigating a curriculum resource (MindUP) which led to the inclusion of two studies with first author K. Thierry (n= 2). This culminated in a total of nine studies included in the final synthesis.

The filters for publication date were left open during the search process, but the final articles that met the previously described search criteria were all published in the last five years (2015-2019). Prior to these dates it seems many researchers examined EF in correlational studies and were still determining the components of EF rather than intervening upon them intentionally.

Data evaluation

After completing the search process described above, the studies were examined using a coding matrix. The initial coding matrix included the following categories: 1) study characteristics, 2) participant characteristics, 3) intervention characteristics, and 4) reported effects on executive function skills. "Study characteristics" included codes for year of publication, research design, control condition, sample size, and setting (see Table 2.1, Appendix A). "Participant characteristics" included codes for child age, race and ethnicity, socio-economic status, disability status, and other student level variables. To answer the first research question concerning intervention characteristics, studies were examined to create a coding matrix examining the curriculum, content, practices, and features described in each study (see Table 2.2, Appendix A). The subsequent "intervention characteristics" codes were created by directly reading the intervention descriptions provided by the authors and developing a coding scheme based on the features of interventions which authors commonly described. Studies was marked "yes" or "no" for the presence of the feature for each coding category based on the author's provided description of the intervention components in the published study or in the supplementary materials (see Table 2.3, Appendix A). To answer the second research question concerning the reported effects of interventions on executive function skills, each study's selection of executive function measures and reported outcomes on these measures were coded. If the authors distinguished a measure as an "executive function" measure it was included which occasionally also included terms commonly used in EF literature such as: self-regulation, response inhibition, attention control, attention shifting, cognitive flexibility, and working memory (Bailey, R., Barnes, S. P., Park, C., Sokolovic, N., & Jones, S. M., 2018). Finally, studies were coded for by the analyses run and any calculated effect sizes on children's executive function measures.

Results

The corpus of studies (N=9) will be discussed first in terms of study characteristics, intervention characteristics, and a discussion of the EF measures and the corresponding effects.

Study Characteristics

Research Design. When examining the designs of each study, five included studies were quasi-experimental and four had evidence of randomized assignment of participants (see

Table 1). The assignment level ranged from occurring at the school level (n=1), a grade level within a school (n=1), the classroom level (n=4), and the individual level of assignment (n=3). Across all nine studies, eight studies used a pre and post-test design, while one study did not include a pre-test (Wood et al., 2018). Four studies included a follow-up assessment, with the earliest follow-up occurring four to six weeks post intervention (Zelazo et al., 2018) and the most long-term follow-up occurring after an additional year of schooling (Thierry et al, 2016).

Control Conditions. Studies were coded to examine the control conditions compared to the mindfulness-based interventions. Four studies had a business-as-usual control group in which students received typical instruction with no changes in schedule or routines (Flook et al., 2015; Razza et al., 2015; Thierry et al., 2018). Three of the studies included an active control condition which involved interventions related to literacy (Poehlmann-Tynan et al., 2016; Zelazo et al., 2018) or "general curricular skills" (García-Bermúdez et al., 2019). One study had both a business-as-usual condition and an active control in the same study (Zelazo et al., 2018). One study had a waitlist control condition in which students received the intervention after the first cohort (Wood et al., 2018). One study used a historical control group which was described as "business as usual" for the students in a prior school year (Thierry et al., 2016).One study did not utilize a control condition for comparison (Emerson et al., 2017).

Sample Size. The sample sizes ranged from 26 to 296 students, with four out of nine studies using samples of less than 35 students (n=4, 44%). Only two out of the nine studies had sample sizes over 100 participants. The total number of participants across all nine studies was 813. Of the five quasi-experimental studies, one study (Thierry, Bryant, Nobles, & Norris, 2016) had a sample size over 100 participants (N=296). Similarly, when considering the randomized control studies, only one study (Zelazo et al., 2018) had a sample over 100 participants (N= 218). The sample sizes did not vary greatly based on study design.

Setting. The geographic location of studies included two international studies (England, Spain) and the remaining seven studies occurred in the United States. Of the studies in the United States, all seven described the geographic location as occurring in a city or urban area; no rural populations were targeted in the included studies. Most studies occurred in school settings (n= 8, 89%). Of those in school settings, over half occurred as whole-group instruction (n=5, 63%) rather than in smaller groups of students (n=3, 38%).

Participant Characteristics

Age. For inclusion in the present synthesis, studies were limited to those with students under the age of 7. As discussed in the literature review, there is empirical consistency in understanding executive function skills as a unitary construct in the younger years (age 3 to 6 years old) with a multi-component model being more representative at older ages, and especially in adolescence. In the included studies, children ranged in age from 3 to 6 years old. Most studies in this synthesis included students with a mean age between 4 to 5 years old (n=5, 56%) and children with a reported age range between 3 to 5 years old were the focus of three studies.

Race and Ethnicity. In eight out of nine studies, participant race was discussed as a demographic variable. In half of the studies which reported race (n=4, 50%), white or Caucasian students were reporting as making up a majority of the participants. In four studies non-white (e.g., Hispanic, African American) students were reported as the majority group.

Socio-Economic Status. The percentage of students identified as having a low socioeconomic status (SES) was not directly reported or mentioned in two studies. In one study "low SES" status was reported as comprising only 1.4% of the study participants (García-Bermúdez et al., 2019), the remaining studies reported low SES students ranging from 37.9% to 100% of the participant population.

Disability Status and Other Student-Level Variables. The rate of included students with disabilities was not specified in most studies (n=6, 67%). One study centered on the study of children which were born "preterm" (García-Bermúdez et al., 2019). One study included three participants with specific disabilities such as autism spectrum disorder, Down syndrome, and a physical disability (Emerson et al., 2017). English Learner status was mentioned explicitly in five of the studies and not specified in the remaining four. Generally, participants across the studies were inferred to be typically developing based on the information reported.

Study Quality

Using the *Council for Exceptional Children Standards for Evidence-Based practices in Special Education* (CEC Standards; Cook et al., 2014), the studies were coded to examine their quality. While the studies featured in this synthesis do not all include students with disabilities, the CEC Standards provide a recognized standard and systematic approach to coding the studies on eight quality indicators which are relevant and important for all research that impacts students, these indicators are: (1) context and setting, (2) participants, (3) intervention agent, (4) description of practice, (5) implementation fidelity, (6) internal validity, (7) outcome measures/dependent variables, and (8) data analysis (Cook et al., 2014). The CEC Standards indicators are relevant to the research questions of this synthesis and provide important insight into the methodological trends of the 9 mindfulness-based interventions which have qualified for inclusion in the present synthesis. A guidance which corresponds with the CEC Standards and a quality indicator matrix for group comparison research were used to code the studies (Royer et al., 2017; Lane et al., 2014). All nine studies met 100% of the criteria for context and setting descriptions, participant information and appropriate data analysis techniques (Indicators 1,2,8). On Indicator 6, internal validity, all nine studies demonstrated control and systematic manipulation of the independent variable; seven out of nine studies adequately described control or baseline conditions and demonstrated that control and intervention conditions were limited in access to one another (no spill-over). All studies clearly described the procedures for assignment to groups, overall attrition and differential attrition was appropriately low, according to EBP guidelines. For Indicator 3, intervention agent description, only one study did not meet all criteria (García-Bermúdez et al., 2019). Indicator 4, providing an adequate description of the intervention practice, was met for all studies except one (Poehlmann-Tynan et al., 2016). The areas of greatest weakness in this corpus of studies will now be discussed. Indicator 5, implementation fidelity was the quality indicator with the lowest ratings with only three out of nine studies reporting fidelity in terms of adherence to the intervention practice; all studies reported dosage of intervention. Indicator 7, outcome measures and dependent variables, was met by all nine studies on most subcomponents, however, four of the studies did not provide evidence of adequate reliability on EF measures, and six of the studies did not provide evidence of adequate validity on EF measures. When using weighted coding with a criterion of 80% of quality indicators being met, eight out of nine studies met the criteria to be considered evidence based. After examining this corpus of studies using the quality indicators, sample sizes, and reported effects, the practice of mindfulness-based interventions for young children is rated as an “evidence based practice” using the guidance and matrix previously referenced (Royer et al., 2017; Lane et al., 2014).

Studies were also coded using the What Works Clearinghouse (2020) *Procedures and Standards Handbook (4.1)*, which provides guidance on how to evaluate study quality and rigor. The steps include examining the randomization procedures, the sample attrition, and baseline equivalence. Using the guidance studies were subsequently rated as “Eligible to Meet without Reservations,” “Eligible to Meet with Reservations,” or “Does not Meet Standards.” Four studies met the highest criteria of eligibility and were rated “meets the standards without reservations” (studies demonstrated a randomization process and sample attrition was not high). One study was classified as “Eligible to Meet with reservations” (randomization was not present, but baseline equivalence was demonstrated). Four studies were rated “Does not Meet Standards” (these studies did not assign group membership through a random process and did not demonstrate baseline equivalence for the groups in the analytic sample). See Table 2.4 below for the results of coding the nine studies.

Table 2.4

Results of Coding Studies with WWC Procedures and Standards Handbook (4.1)

	Design	Step 1. Study Design. Is intervention and comparison membership determine through a random process?	Step 2. Sample Attrition. Is the combination of overall and differential attrition high?	Step 3. Baseline Equivalence. Is equivalence established at baseline for the groups in the analytic sample?	Ratings Results
Emerson et al. (2017)	QED	No	N/A	No	Does not Meet
Flook et al. (2015)	RCT	Yes	No	N/A	Eligible to Meet without Reservations
García-Bermúdez et al. (2019)	QED	No	N/A	No	Does not Meet

Poehlmann-Tynan et al. (2016)	RCT	Yes	No	N/A	Eligible to Meet without Reservations
Razza et al. (2015)	QED	No	N/A	No	Does not Meet
Thierry et al. (2016)	QED	No	N/A	Yes	Eligible with Reservations
Thierry et al. (2018)	QED	No	N/A	No	Does not Meet
Wood et al. (2018)	RCT	Yes	No	N/A	Eligible to Meet without Reservations
Zelazo et al. (2018)	RCT	Yes	No	N/A	Eligible to Meet without Reservations

Note. QED= quasi-experimental; RCT= randomized control trial; N/A = not applicable

RQ1: What are the characteristics of mindfulness-based interventions which target young children's executive function skills?

To answer the first research question, the studies were coded for intervention characteristics by examining the author provided description of the intervention such as intervention title or curriculum name, implementer, setting, group size, duration and frequency of intervention, intervention session outline, "other" features described by the authors, and the presence of supplementary materials or tables. Following this initial coding, intervention component themes emerged, and this led to the creation of a second coding matrix of intervention content to examine trends across interventions (see Table 2.3, Appendix A).

Across all nine studies, eight distinct curricula were implemented (see Table 2). The only curriculum used in two studies is entitled the "Kindness Curriculum" (KC; Flook et al., 2015; Poehlmann-Tynan et al., 2016). The content and features of each curriculum will be discussed further in the "content" section. In three out of nine studies the intervention was implemented by the classroom teacher (Razza et al., 2015; Thierry et al., 2016; Thierry et al., 2018). Trained instructors, therapists, and graduate students were the implementers in the remaining studies.

The location of interventions across all nine studies ranged from the general classroom, small-group spaces, and included one non-school setting (García-Bermúdez et al., 2019). Three studies cited a small group environment was used for intervention implementation (Poehlmann-Tynan et al., 2016; Wood et al., 2018; Zelazo et al., 2018) and five studies described interventions as being conducted whole group in the general classroom setting (Emerson et al., 2017; Flook et al., 2015; Razza et al., 2015; Thierry et al., 2016; Thierry et al., 2018). The length of the intervention window or the duration of the intervention ranged from four weeks to year-long interventions (see Table 2). One intervention was four weeks in length (Emerson et al., 2017), two were six weeks in length (Wood et al., 2018; Zelazo et al., 2018), three interventions were 12 weeks in length (Flook et al., 2015; Garcia et al., 2019; Poehlmann-Tynan et al., 2016), and three interventions were 25 weeks or approximately spanned a school year in duration (Razza et al., 2015; Thierry et al., 2016; Thierry et al., 2018). The frequency of intervention ranged from as little as once per week for two and a half hour sessions (Garcia et al., 2019), twice per week for 20 to 30 minutes sessions (Emerson et al., 2017; Flook et al., 2015; Poehlmann-Tynan et al., 2016; Wood et al., 2018), or a combination of daily practices and ongoing lessons (Razza et al., 2015; Thierry et al., 2016; Thierry et al., 2018, Zelazo et al., 2018).

A session outline provides a general sequence of activities that were present in the intervention (see Table 2.2, Appendix A). Five studies provided outlines of the session sequence (Emerson et al., 2017; Flook et al., 2015; Poehlmann-Tynan et al., 2016; Wood et al., 2018; Zelazo et al., 2018). This inclusion is of practical significance as it provides more clarity about how the mindfulness-based intervention was conducted. One study provided a description of the times of day that the daily practices of mindfulness occurred which was more relevant to this study as the intervention did not rely on lessons as much as daily practices (Razza et al., 2015). After exploring the intervention descriptions, common intervention activities and content codes emerged and were used to create a matrix to examine the trends across studies (see Table 2.3, Appendix A). All nine studies included a meditation, stillness, or mindful bodies practice as well as some emphasis on mindful movement or motor behavior. Eight out of nine studies indicated an emphasis on the senses or sensory experiences (e.g., taste, smell, hearing, listening, touching), only one study did not include this content focus (Razza et al., 2015). Seven of the nine studies specifically described breathing practices while two interventions did not (Emerson et al., 2017; Garcia et al., 2019). A “mind jar” or glitter jar which is often used to simulate the experience of settling student brains or bodies was cited in five out of nine studies (Flook et al., 2015; Poehlmann-Tynan et al., 2016; Thierry et al., 2016; Wood et al., 2016; Zelazo et al, 2018). A kindness, compassion, or empathy focus was described as a feature of the intervention in four studies (Flook et al., 2015; Poehlmann-Tynan et al., 2016; Thierry et al., 2016; Wood et al., 2018). Four studies included a read-aloud element (Flook et al., 2015; Poehlmann-Tynan et al., 2016; Wood et al., 2018; Zelazo et al., 2018); In Poehlmann-Tynan et al (2016) a read-aloud occurred in every session. In two studies the parts of the brain were explicitly discussed during the intervention (Thierry et al., 2016; Thierry et al., 2018).

RQ2: What are the effects of mindfulness-based interventions on the executive function skills of young children?

Across all nine studies, 17 distinct measures were used by the authors for the stated purposes of assessing student executive function and self-regulation skills. There were four measures which were used commonly across studies: The Head-Toes-Knees-Shoulders Task (HTKS; McClelland et al., 2014), The Flanker task (Zelazo et al., 2013), Children's Behavior Questionnaire (CBQ; Rothbart et al., 2001) and the Behavioral Evaluation of Executive Functioning, Children's Version (BRIEF-P; Gioia et al., 2003). Most studies used at least one measure which attempts to directly measure EF through student assessment (n=6, 66%), while three studies relied solely on indirect measures or rating scales completed by parents or teachers. A challenge of interpreting findings in studies which intend to measure executive function skills is the ongoing debate and research to determine which measures distinctly measure executive functions skills and which measures actually measure other developmental domains (e.g., child temperament, self-regulation, problem solving, grit). In a recent report submitted to the Office of Planning, Research, and Evaluation (within the U.S. Department of Health and Human Services) a team of researchers created a resource to help in the selection of measures related to executive function skills and other regulation skills in early childhood (Bailey et al., 2018). This report provides an overview of measures often used in early childhood and provides categorization and sample analyses of the measures to provide perspective on which assessments are best suited to measure differential domains of child development (e.g., executive function skills, social skills, temperament). In order to better understand the findings in the nine studies included in this synthesis, it is important to parse out the measures used and consider whether the measures are considered EF measures or perhaps provide other developmental information about children. The categorization of the measures is also relevant as researchers consider which measures are most age appropriate for measuring

EF. In the opening literature review, the case was made for a unitary construct of EF in the early ages (birth to six years old) as this is a time when the three domains of EF (cognitive flexibility, inhibitory control, and working memory) are working closely together and may not yet be distinguishable (e.g., Brydges et al, 2012). While the literature seems to support this unitary construct, it will be apparent in the subsequent analyses that studies use a combination of measures which target overlapping developmental domains and do not always purely measure EF.

Using the previously mentioned report, the measures from all nine studies have been coded and organized into common categories of measurement. The subsequent categories are as follows: measures of delay of gratification, inhibition, temperament, self-regulation, and executive function (see Table 2.5, Appendix A). The measures which were not included in the 2018 report and required additional analyses and will be discussed separately (see Table 2.6, Appendix A). The measures which were included in the EF compendium will be discussed below alongside the reported effect sizes within their respective domains of measurement (see Table 2.5, Appendix A).

Measures of Delay of Gratification. One measure of delay of gratification (as categorized by the “Executive Function Mapping Project Measures Compendium”) was used by one included study (Flook et al., 2015). A task which is considered a delay of gratification task assesses the “ability to voluntarily postpone immediate gratification and persist in goal-directed behavior for the sake of later outcomes” (Bailey et al., 2018). The Delay of gratification task (based on Prencipe and Zelazo, 2005) was described by the authors in Flook et al. (2015) as involving students choosing between tangible rewards (e.g., food, crayons, tokens) now or a larger reward later. The authors reported that RMANOVA analysis was not significant on this measure. Between group effects (Cohen's d) were reported as a "small" effect across all trials (*d*=0.23; Flook et al., 2015).

Measures of Inhibition. Three measures of inhibition (as categorized by the "Executive Function Mapping Project Measures Compendium") were used across three of the included studies. In two of the studies the Flanker task was used (Flook et al., 2015; Thierry et al., 2018), this task is considered a measure of inhibition which also requires attentional control (Bailey et al., 2018). In Flook et al. (2015), repeated measures analysis of variance (RMANOVA) were conducted with baseline scores as covariates to assess the group by time interactions, on the Flanker task the RMANOVA was not significant, $F(1,56) = 0.62$, $p = .434$. The reported between group effect size was labeled by the authors as "small in magnitude" (d= -0.17) and favored the control group relative to the mindfulness-based intervention group (Flook et al., 2015). In Thierry et al. (2018) simple effects analysis indicated that students in the mindfulness condition had quicker reaction times at the end of the year, $F(1, 294) = 7.74$, $p < .01$, however this difference was explained by students in the control group reacting more slowly at year end and students in the intervention condition showing no difference when comparing their beginning and end of year reaction times. Thus, in both studies results did not indicate a significant effect of intervention on student inhibition as measured by the Flanker task. One other measure of inhibition was used across studies, the Go/No-Go Task (Yong-Liang et al., 2000). In Poehlmann-Tynan et al. (2016) the Go/No-Go task was analyzed in two parts: "Hits" and "correct rejections." At post-intervention, when comparing active control and intervention condition, there was a significant interaction between group and time, $F(4, 38) = 3.36$, $p = 0.05$, $\eta 2 = 0.18$, which the authors described as a "moderately large effect" and comparisons in intervention group differences between time 1 and time 2 were significant and were described as "large effects" $F(2, 19)=4.70$, $p= 0.02$, partial $\eta 2 = 0.33$ (Poehlmann-Tynan et al., 2016). Thus, the findings of Poehlmann-Tynan et al. (2016) may indicate their intervention led to greater gains in student inhibition compared to the other studies (Flook et al., 2015; Thierry et al., 2018) which also measured this domain of executive function skills.

In two of the studies Pencil/Peg -Tapping Task (Diamond and Taylor, 1996) was used, this task is considered a measure of inhibition which also requires working memory (Bailey et al., 2018). In Razza et al. (2015) regression models indicated a significant effect of intervention condition on the pencil-tapping task, $B = 0.28$, $t = 2.39$, partial $\eta 2 = 0.19$, $p < 0.05$, the partial eta squared indicated that treatment group status accounted for 19% of the variance on this measure of inhibition (Razza et al., 2015). When the authors ran additional regressions including the child's initial score as a moderator of the treatment effect, a significant interaction was found; the pattern indicated that intervention was most effective in promoting improvement on the task for students with lower initial inhibitory control in the fall, $F(3, 24)= 21.53$, $p < .01$, $\Delta R2= 0.05$, the reported interaction term effect indicated that treatment group status explained 18% of the variance in student inhibition, partial $\eta 2 = 0.18$ (Razza et al., 2015). In Zelazo et al. (2018), there was no reported effect of condition and no interaction on the Peg-tapping task.

Measures of Self-Regulation. Four measures of self-regulation (as categorized by the "Executive Function Mapping Project Measures Compendium") were used across three of the included studies. In two of the studies the Behavioral Evaluation of Executive Functioning-Children's Version (BRIEF-P) was used (García-Bermúdez et al., 2019; Thierry et al., 2016), this task is considered a measure of self-regulation and a lower score indicates better self-regulation (Bailey et al., 2018). In García-Bermúdez et al. (2019) the measure was completed by parents and the authors reported that statistically significant differences were found on the inhibition factor, for the time of testing by group interaction, F (1, 66) = 5.19, *p* =0.026. An effect size was calculated for the control group's change from pre and post (*d*= 0.39); additionally, given the mean and standard deviations reported by the authors, a Hedge's *g* effect size was calculated by the first author of this paper, comparing the post-test scores on the inhibition factor for both groups (*g* = 0.04). In Theirry et al. (2016) the BRIEF-P was completed by parents and teachers for each participating child. On the teacher reports at post-test students in the intervention condition had lower working memory scores (i.e. improved self-regulation) than those in the control condition, $F(1, 45) = 11.73$, $p < .01$, $d = -1.02$, and lower plan/organize scores $F(1, 45) = 15.49$, $p < .01$, $d = -1.17$ (Thierry et al., 2016). On the parent reports, no main effects or interactions were found (Thierry et al., 2016). When comparing these two studies, it seems that Thierry et al. (2016) may have seen more improvement on student self-regulation than that which was reported in García-Bermúdez et al. (2019). In Razza et al. (2015) two measures of self-regulation were present, the Toy Wrap task and the Toy Wait task. Regression models were run by the authors to examine the main effects of the intervention on the outcomes and the authors described the findings as indicating a significant effect on the toy wait task (B= 0.36, t = 1.96, partial η2 = 0.13, *p* = .06), using the means and standard deviations provided by the authors an additional effect size (Hedge's *g*) was calculated for the toy wait task by the first author of this paper (*g*= 0.32), additionally the calculated effect size for the toy wrap task was the same (*g*=0.32). However, only the Toy wait test resulted in a significant t-test ($t = -1.95$, $p <. 10$). When the authors ran additional regressions including the child's initial score as a moderator of the treatment effect, a significant interaction was found; the pattern indicated that intervention was most effective in promoting improvement on the task for students with lower initial self-control in the fall, $F(3, 25) = 3.63$, $p < 0.05$, $\Delta R2 = 0.22$, the reported interaction term effect indicated that treatment group status explained 25% of the variance in student inhibition, partial $\eta 2 = 0.25$ (Razza et al., 2015). Possible ceiling effects should be taken into consideration with this data point, as at post-test all students in the intervention group were able to wait the full 60 seconds on the Toy Wait Task (Razza et al., 2015).

Measures of Temperament. One measure of temperament was used across two of the included studies. The Children's Behavior Questionnaire (CBQ; Putnam and Rothbart, 2006) is considered a measure of child temperament (Bailey et al., 2018). In Razza et al. (2015), two subscales of the CBQ were used: attentional focusing and inhibitory control. On this measure, higher scores indicate more adaptive functioning. The t-tests and analyses of the CBQ measures at post-test were non-significant as were the interaction terms. In Zelazo et al. (2018) teachers completed the measure "Very Short Form" known as CBQ-VSF. This study included a control, an active control (literacy) condition, as well as a mindfulness plus reflection training. When the authors reported the effect of condition, the literacy condition was rated highest at all time points. There was no difference in scores which interacted with group condition. In both studies it seems that the intervention did not have an effect on child temperament as measured by the CBQ.

Measures of Executive Function. Three distinct measures of executive function skills (as categorized by the "Executive Function Mapping Project Measures Compendium") were used in the included studies. If the description of the task or measure indicates that multiple components of EF are targeted by the measure (working memory, attention shifting/flexibility, inhibition), then the measure meets the criteria to be considered as a measure of EF specifically (Bailey et al., 2018).

In two of the studies the Head-Toes-Knees-Shoulders Task (HTKS) was used (Poehlmann-Tynan et al., 2016; Zelazo et al., 2018), this task was coded as a measure of executive function because the authors of the compendium posit that the task requires inhibition, working memory, and attention shifting as the student is given directions and instructed to do the opposite of the experimenter (Bailey et al., 2018). In Poehlmann-Tynan et al. (2016) the HTKS task was analyzed using RANCOVA. At post-intervention, when comparing active control and intervention condition, there was a significant interaction between group and time, $F(4, 19)=3.28$, $p < 0.021$, partial $\eta 2 = 0.26$, with students in the mindfulness intervention demonstrating increases in EF (as measured by HTKS), however pairwise comparisons of group differences from pre to post-test was non-significant (Poehlmann-Tynan et al., 2016). In Zelazo et al. (2018), repeated measures ANOVAs were used to analyze the performance of three groups (control, literacy, and mindfulness plus reflection training) and there was no reported interaction between time and condition on the HTKS task. However, planned contrasts between the mindfulness intervention and the business as usual control group were significant with the intervention condition performing better at immediate posttest $t(1, 124) = -1.69$, $p = 0.09$, this finding was reported again at follow-up testing $t(1, 129) = -2.23$, $p = 0.03$. The authors do note that the HTKS measure bore the strongest resemblance to the activities occurring in the intervention and suggested that this finding may be considered a near-transfer effect (Zelazo et al., 2018).

The Minnesota Executive Function Scale (MEFS; Carlson and Zelazo, 2014) was also included as a measure in Zelazo et al. (2018) and is coded by the compendium of EF measures to be a measure of EF as the task targets the multiple components of inhibition, working memory, and shifting. In Zelazo et al. (2018) no effect of condition or interactions was significant on this measure. Additionally, a composite EF score was created by Zelazo et al. (2018) which was comprised of HTKS, MEFS, and peg-tapping. On this composite score of EF there was no effect of condition or an interaction effect; however, in planned contrasts the mindfulness group outperformed the control group at immediate follow up $t(1, 124) = -1.66$, $p = 0.10$), and showed statistically significant differences at the four to six week follow-up $t(1, 124) = -2.16$, $p = 0.03$); while the literacy group did not show significant differences when compared to the control group at any time point (Zelazo et al., 2018).

The Dimensional change card sort task (DCCS) requires multiple subcomponents of EF be engaged by the child during testing (inhibition, working memory, and attention shifting; Bailey et al., 2018). In Flook et al. (2015) the DCCS was analyzed in two parts “all trials” and “post switch” and no significant RMANOVA analyses were noted. When the authors examined between group effects (Cohen’s *d*) they described a “small to medium effect size” on post switch trials favoring the intervention condition $F(1, 45) = 1.54$, $p = 0.22$, $d = .43$ (Flook et al., 2015) and a "very small" effect size favoring the control group was reported on all trials (d= -0.13). However, this insignificant *p* value should be considered when interpreting this effect the authors have reported.

Additional Measures. Six measures were used across the corpus of studies which were not included in the compendium of EF measures and thus were unable to be coded by the categories discussed above. The following measures and effects will be grouped by the study they were used within and will be described in the terms used by the authors rather than the compendium (see Table 2.6, Appendix A).

In Emerson et al. (2017) two measures were used that were not included in the EF compendium, those measures include subtests of the Test of Everyday Attention for Children (TEA-CH; Manly et al., 2001) and Luria's Hand Game (Hughes, 1996). The author describes the TEA-CH as a measure of "attentional capacity" and Luria's Hand Game as a test of "inhibition" (Emerson et al., 2017). For the TEA-CH, two sub-tests (Score! And Walk-don't walk) were used to assess students. It is important to note when examining the reported effects and analyses, that this study did not include a control group but instead used a time-interrupted series data collection design with a baseline (T1), pre-intervention (T2; 4 weeks after baseline), post-intervention (T3; 4 weeks after pre-intervention), and follow-up (T4; 6 weeks after post intervention), the authors assume T1 and T2 provide an assumed trajectory without intervention (Emerson et al., 2017). On Luria's Hand Game, a measure of inhibition, a baseline was not established from T1 to T2, so the results should be interpreted with caution. The authors posit that while the baselines and intervention change scores were not significant, the difference between baseline and follow-up scores at T4 approached significance (Z= -1.909, *p*= .06). On the TEA-CH, a measure of attentional capacity or sustained attention, a higher score indicated increased attention. A baseline was established from T1 to T2 on both subtests of the TEA-CH (Emerson et al., 2017). On the Score! Subtest, a "medium" effect size was reported by the authors (d=.70, 95% CI [0.03, 1.38]) and a Related Samples Wilcoxon Signed Rank test confirmed the significance of improvement (Z= -2.838, *p*= .005). On the WDW Subtest, a "large" effect size was reported by the authors (d= 1.06, 95% CI [0.35, 1.76]) and a Related Samples Wilcoxon Signed Rank test confirmed the significance of improvement (Z= 3.132, *p*= .002).

In García-Bermúdez et al.et al. (2019) the Battery of Computerized Neuropsychological Evaluation of Children (BENCI) is included and is described by the author as a measure of basic neuropsychological domains, including but not limited to attention, memory, and EF. For this analysis, only the working memory domain which is explicitly ties to EF will be discussed and other psychological domains measured on the BENCI will be omitted (e.g., figure comprehension, semantic fluidity). Authors reported marginally significant differences on the working memory domain of the BENCI as well as a “large” effect for the intervention group $F(1, 66) = 3.60$, p =0.06, d= 1.37). This effect size appears to have been calculated by comparing the intervention group’s pre and post-test score (within- subjects effect). When the first author of this paper calculated an effect size comparing the control and intervention group’s post-test results (between-subjects), the result was smaller (d= 0.53).

In Razza et al. (2015) a measure called the Drawing Task or Attention Sustained task from the Leiter International Performance Scale-Revised (Roid and Miller, 1997) is included and is described by the authors as a measure of “sustained attention” and students are assessed on correct and incorrect responses. On this measure no significant findings or effects were reported for the students in the intervention condition (Razza et al., 2015).

In Thierry et al. (2018) the Hearts and Flowers Task is included and is described by the author as assessing “all three components of core executive functioning, including inhibition, working memory, and cognitive flexibility” (Thierry et al., 2018). The task is scored in three blocks of tasks with accuracy and reaction times measured in each block. Authors reported that simple effect analyses indicated that students in the mindfulness condition demonstrated faster processing from beginning to end of year $F(1, 156)= 37.71$, $p <.01$, d= -0.56 (within group effect) while no difference was found in control schools; quicker reactions compared to control schools were also reported $F(1, 294)= 7.27$, $p <.01$, $d= -0.31$ (Thierry et al., 2018). On the measure of accuracy on the Hearts and Flowers task, there was no effect of group condition.

In Wood et al. (2018) a teacher perceived rating form was created by the authors was included and is described by the author as a measure of progress in EF and social skills. The measure is a rating form with five domains: attention, working memory, inhibition, shifting, social skills (Wood et al., 2018). As this measure was created by researcher for this study, no reliability information is available and the reported effects should be cautiously interpreted. Of the nine studies in this synthesis, this is the only study with a sole outcome measure of EF which has been created by the researcher. This study used a waiting control design in which cohort 2 received the intervention in the spring, and cohort 1 received the intervention in the fall. Cohort 1 showed no significant differences when compared to cohort 2 at the end of the fall intervention cycle, however a significant difference in working memory was found at the end of the spring for cohort 2, Wilk's lambda = .813, $F(1,19)= 4.381$, $p= .05$. Effect sizes were reported and coded by the author as small to medium for all domains of the measure in favor of cohort 2 at the end of the spring intervention, but none of the reported *p*-values indicated these differences were of statistical significance, so the effects are not reported here (Wood et al., 2018).

Follow-up Data. Additional assessments after the immediate intervention post-testing occurred in a subset of studies (n= 3, 33%) while most studies did not collect follow-up data on the maintenance of reported changes in EF. In Emerson et al. (2017) follow-up testing occurred six weeks following the intervention and was collected on Luria's Hand Game (but not the TEA-CH measures) and the authors reported that the difference between baseline and follow-up scores approached significance (Z= -1.909, p= .06), however baseline was not established on this measure so this result should be interpreted with caution. In Poehlmann-Tynan et al. (2016), data was collected three months following intervention. On the HTKS task, a measure of EF, when comparing active control and intervention condition at pre-test and follow-up, there was a significant difference in scores, $F(2, 19) = 6.22$, $p = 0 .008$, partial $\eta 2 = 0.04$, with students in the mindfulness intervention demonstrating increases in EF. On the Go/No-Go Task of inhibition, no significant differences were reported from pre-intervention to follow-up, or post-intervention to follow-up. In Zelazo et al. (2018) students were tested at pre, post, and four to six weeks following intervention at follow-up. On the HTKS, a measure of EF, planned contrasts between the mindfulness intervention and the business as usual control group were significant with the intervention condition performing better at follow-up testing $t(1, 129) = -2.23$, $p = 0.03$ (Zelazo et al., 2018). On the Peg-tapping task and MEFS, measures of inhibition and EF respectively, no group advantage was seen at follow-up. On the composite score of EF (HTKS, MEGS, Peg-tapping), in planned contrasts the mindfulness group showed statistically significant differences at the four to six week follow-up $t(1, 124) = -2.16$, $p = 0.03$); while the literacy group did not show significant differences when compared to the control group at follow-up.

Discussion

Executive function skills (cognitive flexibility, inhibitory control, working memory) are conceptualized as a “family” of neurocognitive skills that are active when a child or adult is concentrating, making decisions, and managing impulses and are thus critical across the lifespan in an increasingly complex world (Diamond, 2016). EF skills are considered building blocks of learning as they underlie goal-directed behavior (Griffin et al., 2016) and EF targeting interventions continue to be of interest to researchers and practitioners as students with low or poor initial EF skills (e.g., students who are lower-income, children with ADHD) generally demonstrate the most benefit from intervention programming; EF interventions may be an under-realized avenue to closing the achievement gap (Diamond & Lee, 2011).

In Takacs & Kassai (2019) meta-analysis of EF interventions, mindfulness-based interventions demonstrated effects beyond that of other intervention categories providing strong empirical support for this method of intervention. Mindfulness can be described using a two-component model, the first component being self-regulation of attention on the present moment, the second component being attitude toward one's experiences in the present moment (Bishop et al., 2004). The Shapiro et al. (2006) framework provides a theoretical grounding to explain how mindfulness practices which engage the participant's attention, intention, and attitude, ultimately lead to a change in perspective (meta-mechanism: reperceiving) which subsequently enhances other direct mechanisms, such as executive function skills.

The younger years have been highlighted as an especially beneficial time to intervene and target EF skills (Griffin et al., 2016) and this synthesis limited the corpus to studies which included children under age seven. Nine studies qualified for inclusion in this synthesis and when this corpus of studies was evaluated using the CEC Standards the practices of mindfulness-based interventions for young children was found to be an "evidence-based" practice, which replicates work highlighting the effects of mindfulness-based interventions (e.g., Takacs & Kassai, 2019). Studies were also coded using the What Works Clearinghouse (2020) Procedures and Standards Handbook (4.1), four studies met the highest criteria of eligibility to meet the standards without reservations (studies demonstrated a randomization process and sample attrition was not high). which indicates that the methodology of studies examining mindfulness-based interventions and EF skills is continuing to improve.

While a recent meta-analysis (i.e., Takacs & Kassai, 2019) provided a deep-dive into the effects of a broad range of interventions on executive function skills, this paper has provided descriptions of the intervention content and curricula as well as a more narrative description of the nuances of the effects documented within each of the nine studies. This paper also integrates the work of other researchers who have created resources, such as the “EF Mapping Project Measures Compendium,” which will hopefully lead to greater preciseness in researchers selecting measures by understanding what these measures most accurately measure (e.g., executive function, temperament, social skills).

Limitations in Existing Literature

The authors of the EF measures compendium note that assessing EF using a single task such as the DCCS, MEFS, HTKS measure is less complex than assessing EF using a battery of tasks, which they posit may better capture each of the multiple dimensions of EF (Bailey et al., 2018). This guidance still leaves much room for interpretation and exploration of what a truly comprehensive and appropriate battery of EF measures should (or should not) include. Across the corpus of studies, 17 measures were used, which highlights the challenges of conceptualizing, measuring and making subsequent comparisons across studies. Often studies report the accuracy, reaction times, and various trials of a task as separate scores and calculate matching effect sizes; this practice creates some confusion when attempting to determine where to draw comparisons. For this reason this synthesis has taken a more narrative format in expressing the findings, allowing the reader to weigh the individual author’s presentation of their own findings and the provided descriptors of effect sizes, which should always be taken with caution as the reader considers the corresponding sample size and study design.

The samples of students across studies was relatively diverse on the demographic variables of race, ethnicity, and socioeconomic status, however, the presence or reporting of student's disability status was limited as was the presence of students who are learning English or other languages. Most studies included typically developing students and it will be important for future research on mindfulness-based interventions to increase the sample of students included with varying disabilities and developmental needs.

Most studies in this synthesis occurred whole-group, in the general classroom, however only three studies relied on the general-education teacher to provide the intervention. Subsequent studies should attempt to implement curriculum by training and coaching the classroom teacher and determine if the presence of a trained researcher or therapist is leading to differential outcomes. Additionally, the amount of teacher or implementer training and coaching provided was not consistently described or reported, but in one study the coaching was described as on-going and the teachers implementing the intervention were observed and given feedback on a monthly basis (Thierry et al., 2018). Meanwhile some studies indicated that one day of training was provided to teachers (e.g., Thierry et al., 2016). The presence of teacher coaching may have cascading effects and could be a necessary active control condition in order to understand if coaching itself is a significant enough intervention beyond the student facing mindfulness curriculum.

Strengths in Existing Literature & Further Recommendations

A previous review of mindfulness-based interventions in school settings indicated that most studies relied on questionnaire data and student reports as outcome measures and suggested the need for diverse outcome measures in future studies (Felver et al., 2015). In the present synthesis most studies included both direct measures of EF and rating scales, with only three studies relying solely on rating scales to measure EF (García-Bermúdez et al., 2019, Thierry et al., 2016; Wood et al., 2018). This indicates a positive trend that should be continued as studies should seek to clarify the intended target of intervention and select corresponding measures which are reliable and valid. In a majority of studies (n=6, 67%) the authors provided access to supplementary materials or included a table which provided more information about the intervention components and lesson sequences; three studies did not provide these materials which causes reliance on the narrative description to understand the intervention elements (Emerson et al., 2017; García-Bermúdez et al., 2019; Razza et al., 2015). This is a promising trend as explicitly describing intervention features and content is of practical significance to practitioners and other researchers as future interventions are designed. By coding the studies for intervention content and exploring unique elements, features of the interventions which may warrant further research and consideration came to the surface. The inclusion of parent-newsletters or communication about the intervention occurring at school was present in one study (Wood et al., 2018) and it may be important to continue considering the role of sharing information with parents about mindfulness practices. As several studies relied on multiple daily practices of mindfulness (e.g., Razza et al., 2015) it may be useful to document parent reports of children transferring mindfulness-based practices to other settings, such as at home.

Trends emerged across all nine studies when examining intervention content and activities, these trends included meditation and mindfulness practice, a focus on mindful movement, and mindful breathing. Secondary categories which commonly were cited included the emphasis on the five senses or sensory awareness and it may be worthwhile to consider which of these components is the most “active” ingredient in the interventions. Do sensory activities, such as focusing a lesson on mindful smell or taste have a distinct impact on students' mindful awareness and executive function skills? The presence of an intervention lesson involving compassion, kindness, or empathy was present in several studies (n=4, 44%) however a deeper understanding of how these social-emotional and relational skills support mindfulness and executive function skills is still needed. Studies which conduct a component analysis looking at the value of meditation versus a more comprehensive curriculum is needed to further parse out an understanding of what should be included in a mindfulness-based intervention and for whom. In Takacs & Kassai (2019) the authors concluded their meta-analysis having found no evidence that the benefits of EF interventions were sustained over time and stated that mindfulness-based interventions rarely reported follow-up data, however, there seems to have been some level maintenance present in Zelazo et al. (2018). Future studies which measure longitudinal impact of EF are likely necessary as only three studies in this synthesis included follow-up testing.

Conclusion

Mindfulness practices when conceptualized as a two part model requires self-regulation of attention in the present moment as well as an ongoing attitude of openness and curiosity (Bishop et al., 2004) thus mindfulness-based interventions should intend to develop students' practice of meditation as well as develop their attitude toward their environment. This definition should cause researchers to consider how to instruct students in the more practice-based elements of mindfulness (e.g., taking a mindful moment for meditation with a timer) as well as how to develop lessons and an intervention sequence that aims to shift students' broader attitudes. Research is indicating that mindfulness may cause neuroplastic changes in the brain (Tang, Hölzel, & Posner, 2015) and thus improve children's executive function skills. Since the publication of Takacs & Kassai (2019), an additional six studies were located which qualified for inclusion in this synthesis, indicating the implementation of mindfulness-based interventions is growing at a rapid pace. Future EF intervention studies are needed which compare the effectiveness of potentially similar or distinct intervention categories such as mindfulness-based interventions and strategy-based or social-emotional learning curriculums and interventions as there may be distinctions or overlapping elements of these intervention types.

Chapter 3: Study 1

The development of executive function (EF) skills in children and the subsequent implications for educational outcomes is a burgeoning field of research. In 2016, the Institute of Education Sciences published a review of research on EF entitled, "Executive Function: Implications for Education," which provides an in-depth description of executive function (EF) skills, correlational research, intervention research, and implications for the field (Zelazo et al., 2016). EF skills are attention-regulating skills that facilitate the focus and stamina often required for school success (Zelazo et al., 2016). Diamond (2013) defines executive functions (EFs) as a "collection of top-down control processes used when going on automatic or relying on instinct or intuition would be ill-advised, insufficient, or impossible."

A complexity of studying EF skills is the diversity of definitions that spring from different theoretical frameworks, with some conceptualizing EF as a unitary construct and others considering EF to contain distinct and simultaneously interrelated components (Best & Miller, 2010). In studies of children ranging in age from three to six, a unitary construct of EF has been identified as the best fit (Hughes et al., 2009; Shing, et al., 2010; Wiebe et al., 2007; Willoughby et al., 2012). It is hypothesized that the distinctions among EF domains begin to crystalize and are more distinctly measurable as students exit preschool contexts and advance to elementary and middle school (e.g., Shing et al., 2010). The unitary construct appears the most appropriate for young children and as such this framework will go on to inform the measures chosen for this study of young children's EF skills.

The three domains of EF skills are distinguishable but coordinate very closely, and are often described as cognitive flexibility, working memory, and inhibitory control (Center on the Developing Child at Harvard University, 2011; Diamond, 2013; Zelazo et al., 2016). *Cognitive* *flexibility* involves the mental task of switching between concepts, such as a student reading a compound word as a whole word (e.g., "butterfly") while also recognizing the individual words within the word (e.g., "butter" and "fly"; Zelazo et al., 2016). Diamond (2013) defines cognitive flexibility as "changing perspectives or approaches to a problem flexibility adjusting to new demands, rules, or priorities (as in switching between tasks)." *Working memory* involves storing information and manipulating it, as is experienced when bringing together sections of a reading passage to achieve comprehension of the whole (Zelazo et al., 2016). Working memory is defined as "holding information in mind and mentally working with it (e.g., relating one thing to another, using information to solve a problem; Diamond, 2013). The third component of EF skills, *inhibitory control,* involves suppressing distraction and maintaining attention on a specific object or task (Zelazo et al., 2016). Inhibitory control is also sometimes labeled "inhibition" and is defined as "controlling one's attention, behavior, thoughts and/or emotions to override a strong internal predisposition or external lure" (Diamond, 2013). These skills coordinate and work together to support learning and well-being throughout a person's life (Griffin et al., 2016).

The Relationship among Academic Achievement, Behavior, and EF

EF skills are important for school readiness and are more strongly associated with school readiness than are IQ or entry level performance in reading or math (Blair, 2002; Blair & Razza, 2007; Morrison et al., 2010). A student's EF skills in early childhood can be highly predictive of EF skills in adolescence and adulthood and evidence is accumulating which indicates that trying to improve EF in the early years may be the most critical and promising time to intervene (Griffin et al., 2016). Executive function skills in kindergarten have been found to predict academic achievement in math, reading, spelling and writing at the end of first grade (Monette et al., 2011; Vandenbroucke et al., 2017). In a study of 6 and 7 year olds' EF skills and math achievement, findings suggested that strong EF skills in the early primary school years may enhance math performance and may lead to an advantage when increasingly abstract concepts are introduced in the math curriculum (Mazzocco & Kover, 2007). A positive relation between EF skill development, prosocial behavior, and school performance has also been documented (Motamedi et al., 2016; Zorza et al., 2016). This correlational research has provided insight and provoked interest in examining how EF skills intersect with academic and behavioral outcomes and it has caused many to wonder if EF is responsive to intervention.

Interventions to Improve EF

Categories of EF interventions have been documented and in one recent meta-analysis of interventions targeting EF skills the studies were coded and organized by the following intervention types: explicit practice (computer and non-computer training), physical activity, EF-specific curricula, art activities, and providing new strategies of self-regulation (mindfulness practice, biofeedback- enhanced relaxation, strategy teaching interventions; Takacs & Kassai, 2019). Overall a positive effect was found across all intervention studies (g=.30) and effects ranged in the categories of interventions from .12 to .46. The categories specific effect sizes were as follows: explicit practice (g=.38), physical activity (g=.16), EF-specific curricula (g=.12), Art activities (g= .07), and providing new strategies of self-regulation (g=.46; Takacs & Kassai, 2019). From this comprehensive meta-analysis, "providing new strategies of self-regulation" emerged as the category with the largest overall effect size. The "new strategies of self-regulation" category was defined by using the following subcategories: mindfulness practices (g=.46), biofeedback-enhanced relaxation (g= .93), and strategy teaching interventions (g=.30). While biofeedback-enhanced relaxation demonstrated a large effect size, the authors of the meta-analysis concluded the paper by discussing the likely higher expenses of biofeedback techniques. Thus, the two other strategies in this category: strategy teaching interventions and mindfulness practices are likely intervention approaches worthy of further exploration in school settings.

Social Emotional Learning and EF

Social-emotional learning (SEL) has been identified as a possible intervention avenue for improving EF as it explicitly teaches a student about problem solving and emotion regulation (Bierman & Torres, 2016). SEL has been defined as “the processes of developing social and emotional competencies in children” and this learning can occur through direct social and emotional skills instruction and practice as well as engagement in practices that foster positive interactions and relationships between students and teachers (Collaborative for Academic, Social, and Emotional Learning, 2013). Social-emotional learning curriculums, such as PATHS (Promoting Alternative Thinking Strategies), have demonstrated positive effects on student executive function (Bierman et al., 2008; Riggs et al., 2006). PATHS focuses on helping children verbalize their feelings, manage emotions, and use explicit signals to support impulse control and problem solving (Bierman & Torres, 2016). In Takacs & Kassai (2019) the included studies which featured the PATHS program were classified as “strategy teaching interventions” the teaching of specific strategies or skills overlaps with the intentions of SEL instruction and curricula and in this paper teaching strategies and skills will be labeled as a “SEL intervention” rather than “strategy teaching interventions.” The curriculum components, which encourage students to self-regulate their emotions and develop problem solving skills, are hypothesized to influence EF skill development. Second Step Early Learning (SSEL) is a strategy based program similar to PATHS and specifically aims to support EF skill development in young children, in a study of community preschools enrolling low-income children, those receiving the SSEL curriculum throughout the year demonstrated significantly greater EF skills at year end (Upshur et al., 2017). While social-emotional learning interventions have been identified as an approach for early EF intervention, further research is warranted with SEL interventions on different age groups of students and for different durations (i.e., less than a year).

Mindfulness and EF

Studies have also been conducted using mindfulness-based interventions targeting EF skills (Flook et al., 2010; Flook et al., 2015; Gallant, 2016; Thierry, Bryant, Nobles, & Norris, 2016; Zelazo & Lyons, 2012). Mindfulness instruction is hypothesized to support the development of self-regulation by targeting top-down processing and simultaneously reducing bottom-up influences, such as anxiety, to promote students' attention and ability to problem solve (Zelazo & Lyons, 2012). Mindfulness trains the participant to focus and return attention when the mind has drifted (Flook et al., 2015). A study of preschoolers which utilized the MindUP curriculum across a school year found positive effects on student EF (Thierry et al., 2016). In another intervention study, preschool children participated in 12 weeks of a mindfulness "Kindness Curriculum" and small to medium effects were found on participating students cognitive flexibility and delay of gratification (Flook et al., 2015). These studies highlight the promise of mindfulness approaches to increasing young students' EF skills, but more research is warranted in order to make comparisons around which age groups, group sizes, and dosages are most effective.

In a synthesis of mindfulness-based interventions targeting EF in young children, eight different mindfulness-based interventions were implemented across nine studies and a significant effect on EF skills favoring the mindfulness-based intervention condition was found on at least one measure in six out of 10 included studies (McCatharn & Taboada Barber, 2020).

Comparing and Contrasting SEL and Mindfulness

In Takacs & Kassie (2019) both intervention approaches, SEL and mindfulness, were categorized under a broad category of "teaching new strategies of self-regulation." Commonalities of these approaches include intentionally teaching skills to participants in order to improve self-regulation and attention. In practice, this is usually done differently in each approach, as mindfulness takes a more reflective approach and SEL relies on direct teaching of strategies and skills. Mindfulness-based interventions focus on building awareness of the self, senses, and the environment as well as practicing meditation or mindfulness. Principles for mindfulness-based interventions have been described as promoting "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (Kabat-Zinn, 1994) additionally mindfulness-based interventions are distinctively oriented toward building self-awareness of participants and use an "inside-out" approach to encourage awareness of inner emotions, thoughts and senses.

SEL interventions often focus on the practice of learning specific skills such as listening when someone is speaking, making eye contact, and learning how to be successful in relationships and in environments (such as at school). Principles for SEL interventions have been summarized in the acronym "SAFE" suggesting that lessons should be sequences, active, focused, and explicit; additionally SEL interventions are distinctively goal oriented and use an "outside-in" approach to train students in prosocial behavior explicitly.

The Present Study

As described, social-emotional learning interventions and mindfulness-based interventions have been documented as promising and effective EF intervention approaches (Takacs & Kassai, 2019). Research suggests that it is important to intervene and support the development of EF skills in the early years (e.g., Diamond & Ling, 2016), yet further research is needed comparing different EF programs implemented in school settings to determine which intervention approaches are most effective. The present study provides a unique comparison of two previously proven approaches to improving EF skills (Takacs & Kassai, 2019): an SEL intervention (based on the Second Step curriculum) and a mindfulness-based intervention (based on the MindUP curriculum). In a synthesis of mindfulness-based interventions targeting EF in young children, four out of nine included studies had sample sizes less than 35 students and only four of the nine studies had a randomized design (McCatharn & Taboada-Barber, 2020). Additionally, four of the studies had a majority Caucasian student population (McCatharn & Taboada-Barber, 2020). The present study has a sample size of 91 students, randomizes students within classrooms into intervention conditions (SEL, mindfulness, and control group), the study participants are majority African-American and attend a school in an under-resourced community. In McCatharn & Taboada-Barber (2020) three studies examined yearlong curricula. The present study was implemented in 11 sessions (over 9 weeks) and was conducted with a small group of students (six students or less) in a pull-out classroom space, outside of the general classroom. By examining the effects of 11, 30-minute intervention sessions using their respective approaches (SEL, mindfulness), one or two times per week for nine weeks, insight may be provided about the threshold of intervention required to see measurable improvement in student EF. This study utilized a within classroom randomized control trial design, which facilitated directly comparing two approaches to improving executive function skills against a control group.

Research Questions

In the present study, I examined the difference in relative effects of two different intervention approaches (SEL and mindfulness) compared to the control group, during nine weeks of intervention for kindergarten students in an urban setting. Two main research questions guided this study: "Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on EF skills over time, immediately following the intervention (T1 to T2)?" and "Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on academic achievement (math and reading) and EF skills over time, at end of year testing (T1 to T3)?" (See Table 3.1).

Table 3.1

Study 1 Design and Testing time points

Condition, Sample Size	Pre-test (T1) Measures	Intervention	Post-intervention (T2) Measures	End of Year (T3) Measures
SEL (n=24)	EF Math Reading	SEL Intervention	EF	EF Math Reading
Mindfulness (n=24)	EF Math Reading	Mindfulness-based Intervention	EF	EF Math Reading
Control (n=44)	EF Math Reading	Business-as-usual	EF	EF Math Reading

Time of Year	*October*	*Oct-Dec.*	*December*	*May/June*

Hypotheses

Previous research has highlighted the utility of SEL curriculum at increasing EF skills (e.g., Bierman et al., 2008; Riggs et al., 2006) as well as mindfulness-based interventions (e.g., Flook et al., 2015; Thierry et al., 2016). Therefore, I hypothesized that the students in both EF intervention groups, the SEL intervention and the mindfulness-based intervention group, would demonstrate higher EF skills after intervention (T1 to T2) compared with control group students. As EF skill development is also predictive of academic success, I also hypothesized that students in the executive function intervention groups may demonstrate academic growth beyond their peers in the control group at end of year testing (T1 to T3). Previous research has indicated that change in EF can be sustained post-intervention, so I hypothesized that students in the intervention conditions may demonstrate sustained increased EF skills at year end (T1 to T3). I did not have a hypothesis about which intervention condition may demonstrate more effectiveness in changing EF skills or academic achievement.

Method

Research Design

This study used a within classroom randomized-control design. Students who completed the first EF assessment at pre-test ("Time 1") were eligible to be randomized and included in the study. Initial pre-testing of EF skills occurred over a two week period and attempts were made to assess all first-time kindergarten students, if a student was not in attendance during the testing window they were not included in the randomization process as there was concern about if the student would be likely to remain enrolled at the school if they were not present for the pre-testing window. As the initial enrollment and count numbers of the school fluctuated at the start of the year it is estimated that there were 97 kindergarten students. Of five students classified as having a disability and receiving special education services, only one student was excluded from the study due to severe autism which rendered the student unable to complete the pre-test. The final sample of students (N=91) were able to complete the pre-test and were included in the subsequent within classroom randomization process. The school had four kindergarten classrooms and students within each of the four classrooms were randomly assigned to mindfulness-based intervention, SEL intervention, or the control group. Randomization occurred by assigning numbers to students in each classroom and then using a number generator to assign students within each classroom to conditions (SEL, mindfulness-based, control). Within each class of 19 to 30 eligible students, six students were randomly assigned to the SEL intervention and six to the mindfulness-based intervention and the remaining 12 to 14 students were assigned to the control group condition. This resulted in 24 students participating in the SEL intervention across four classes, 23 students participating in the mindfulness-based intervention across four classes, and 44 students serving as the control group across four classes (N=91).

Setting and Participants

This study took place in a public charter school in the Mid-Atlantic United States. The student population at the school is reported as 95.9% Black, Non-Hispanic, 2% Multi-racial, and less than 1% of other race and ethnicity categories (Asian, Hispanic/Latino, Native America, White). The school qualifies for the Community Eligibility Provision (CEP), which allows all students to receive free lunch and breakfast. At the time of the study, the school had students enrolled in grades kindergarten through third grade. The participants across all conditions were 91 kindergarten students (44 females, 47 males). The mean age of students was 5.6 years old (*SD* = 0.30). The school was organized with students in four classes, each with approximately 19 to 31 students. The school utilized a departmentalized, rotational model so students rotated between multiple teachers throughout the school day and did not have a single homeroom teacher. Two classes shared a humanities teacher and the other two classes shared a different humanities teacher. All four classes of students had the same math teacher and all four classes also shared the same computer lab teacher. The intervention groups in this study all occurred during the computer lab class which all students in the grade level attend daily. The interventions were conducted by me as the main researcher, the control group condition was led by the computer lab teacher. Four students with disabilities were included in the study alongside their peers, there disability classifications included autism, speech-language impairment (SLI) and two students with developmental disability; one student with severe autism was unable to complete the pre-test measure and required a one-on-one aid at school, this student was excluded from the study.

Procedures

Letters were sent home with each child informing parents of the study and the parents' right to have their child excluded from the study by signing a form and returning it to their child's teacher. No forms were returned. All eligible kindergarten students, who were in attendance during the initial testing window were assessed using the Minnesota Executive Function Scales (MEFS) measure as a part of the study procedures (see below in "Measures" section for further description). Seven students were not assessed due to absences during the testing window and were subsequently excluded from the study. All students who completed the MEFS assessment during the two-week test administration window (N=91) were subsequently eligible for random assignment to intervention or control groups. The randomization process and group assignment procedure was described above in the “Design” section, randomization occurred within classrooms and resulted in 24 students participating in SEL intervention across classes, 23 students participating in mindfulness-based across classes, and 44 students in the control group. A “back-up” student was randomly selected by the random number generator for each class to have a student ready to enter the intervention condition if a student was absent frequently (more than two times) on the days of intervention conditions when the study began. One student who was initially randomly assigned to the SEL intervention was switched to the mindfulness-based intervention due to a necessity of balancing students who exhibited challenging behaviors in the group (the student had a particularly challenging relationship with another student in the group and it was deemed best to separate them for the remaining sessions), the student attended the introduction session and then was switched with another student who had the most similar pre-test MEFS score in the other group. Two students were moved to the control group after missing two intervention sessions in a row within the first three sessions; these changes were made to avoid further absenteeism in the intervention condition (as the intervention groups were smaller than the control group in size). In these cases, a student in the control condition was randomly chosen to move into the intervention condition and begin sessions with the group immediately. After the fourth session, no more changes were made to the groups, regardless of attendance rate. Intervention lesson attendance data was collected throughout the remainder of the study for students in the intervention conditions. Although these shifts to intervention group rosters occurred, these students were later analyzed using an intent to treat (ITT) framework, so as to not compromise the integrity of randomization. All intervention condition sample sizes reported throughout this chapter (in tables and in narrative descriptions) reflect the final sample sizes that resulted from analyzing each student using ITT, this was done for consistency and clarity.

Interventionist. I conducted the interventions within my role as the social-emotional learning specialist at the school. I was employed in the role of social-emotional learning specialist during the prior school year and had approximately five years of prior classroom teaching experience and a dual certification in elementary and special education at the time of this study. I prepared for the intervention lessons by scripting each lesson in a template which outlined the key components. The templates for both approaches are included (see Figure 3.1 and Figure 3.2, Appendix B).

Duration and location. The intervention groups took place one to two times per week (scheduling of one or two sessions per week during the intervention period varied and depended on holidays and other school events), for approximately 20 to 30 minutes per session (session length for each session varied based on factors such as student engagement and lesson components, session length data will be formally analyzed after reviewing the recordings of sessions to determine average length of sessions for both intervention conditions). Both intervention approach groups (SEL and mindfulness-based) began with one introductory session, followed by nine instructional sessions and one closing session, for a total of 11 sessions. The sessions were completed within 9 weeks during the fall semester of the academic year.

When all students attended sessions, the maximum group size was six students. The groups typically met in the interventionist's office, a small classroom with a carpet, table and chairs and a dry erase board. On occasions when this room was unavailable, groups were held in other classroom spaces which were available. Groups were not conducted in the presence of kindergarten teachers or in the same space as control group students. Students in the SEL and mindfulness-based interventions were pulled from their computer lab class. More information about the business-as-usual conditions in the computer lab will be provided in the next section.

Table 3.2

Study 1, EF Intervention Lesson Sequence

Week	SEL Lessons (Second Step)	Mindfulness-based Lessons (MindUP)
1	Introduction & Welcome	Introduction & Welcome
2	Learning to Listen	How Our Brains Work
3	Focusing Attention	Mindful Awareness
4	Following Directions	Focused Awareness: The Core Practice
5	Self-Talk and Staying on Task	Mindful Listening
6	Being Assertive	Mindful Seeing
7	Feelings	Mindful Smelling
8	More Feelings	Mindful Tasting
9	Identifying Anger	Mindful Movement I
10	Same or Different	Mindful Movement II
11	Review and Closure	Review and Closure

Social Emotional Learning (SEL) Intervention

The SEL intervention content was adapted from Second Step, a social-emotional learning curriculum which focuses on explicitly teaching social skills. Second Step is a curriculum with editions created for use with specific age groups, in the present study the kindergarten edition was used. The SEL intervention lessons, based on Second Step, had six components: listening rules, quick review and warm-up, objective statement, story-time and discussion (using the scripted picture card), skill practice (Brain Builder game), and the closing (see Figure 3.1, Appendix B). These components were adapted from the Second Step curriculum and formed the outline of the lesson plan which was scripted by the interventionist and used in each session (see Figure 3.1 and Figure 3.3, Appendix B). A table with the Second Step lesson topics, alongside the MindUP lesson topics for each session is included (see Table 3.2). The lesson topics in the SEL intervention focus on self-regulation and positive classroom behaviors such as "focusing attention" and "listening" and explicitly teaches strategies such as "self-talk" and how to address problems and share personal feelings with others.

As a means of sharing the content with students, the curriculum includes large picture cards featuring a picture of a child and a story to share with the students which illustrates the lesson focus for the session (e.g., a picture shows a student sitting in a circle with her class and she is sharing something with her class after having raised her hand to take her turn, this card tells the story of a group of students who are using the "rules of listening" to pay attention in their kindergarten class). During the intervention, the session topics were taught in the sequence recommended by the Second Step program (see Table 3.1). Additionally, a specific component of the Second Step curriculum is the inclusion of "Brain Builders" which are game-like exercises "which work to build students' attention, working memory, and inhibitory control" (Committee for Children, 2011). These "Brain Builders" were included in the intervention sessions (see Appendix A). Both the content of the skills-focused, picture card-based lessons and the inclusion of the "Brain Builders" activities were hypothesized to improve student executive function skills and were key components of the SEL intervention.

The broader curriculum can last a full-school year, but for the purposes of this study only the first nine lessons of the curriculum were completed, and a review of all lessons was conducted during the closing session. The content of the introductory session was not based directly on the Second Step curriculum and focused on setting behavioral expectations for the group, the students were told the group's purpose was to "to help you grow your brain to help you reach your future goals." There are many components in the Second Step program, as it can be used as a daily program for classrooms. In this study, the SEL intervention utilized Second Step's lesson sequence, picture card driven social skills lessons, as well as the Brain Builder activities which are intended to enhance EF skills.

Mindfulness-Based Intervention

Lessons in the mindfulness-based intervention were developed from an existing curriculum called MindUP. This curriculum has been effective in increasing preschoolers' EF skills (Thierry, Bryant, Nobles, & Norris, 2016), and in the present study the "pre-kindergarten to grade 2" edition was used. The mindfulness-based intervention relied on the MindUP weekly lesson sequence and an increasing amount of mindful attention practice, or timed meditation during each session. The content of the introductory session was not based directly on the MindUP curriculum and focused on setting behavioral expectations for the group by teaching a brief chant about group expectations (i.e., sitting crisscross, raising hands to talk), the students were told the group's purpose was to "to help you grow your brain to help you reach your future goals." The students completed nine sessions following the MindUP lesson sequence and completed a closing session which reviewed the previous session's content. The mindfulness approach group lessons had six components: quick review and warm-up, engage (introduction and objective statement), explore (activity connected to the lesson), reflect (debriefing questions), mindful core practice (time spent practicing mindfulness), and a closing statement. These elements were adapted from the MindUP curriculum to provide a consistent lesson structure and lesson plan template which the interventionist used to script each lesson (see

Figure 3.2 and 3.4, Appendix B). A table with the MindUP lesson topics for each session is included alongside the Second Step lesson topics (see Table 3.2).

The curriculum explicitly teaches students the parts of the brain and how the brain functions which subsequently provides students with insights into their own minds and behaviors and increases their self-awareness (MindUP Manual, 2011). The lesson sequence (see Table 3.2) focused on teaching the “core-practice” of mindfulness meditation followed by teaching students the parts of their brains and providing practice opportunities to focus on each of their senses (e.g., smell, taste, sight, listening). The MindUP creators posit that a child’s increased understanding of their own impulses, thoughts, and feelings ultimately strengthens self-regulation skills (MindUP Manual, 2011). During the intervention, the session topics were taught in the sequence recommended by the MindUP program (see Table 3.1). The curriculum guide lays out each lesson with a warm-up activity, an exploration activity, and reflection questions. By teaching and repeatedly practicing the “Core Practice” of mindful meditation via belly breathing and attentive listening throughout the sessions, students are hypothesized to increase self-regulation. Both the content of the lessons and the inclusion of the “Core Practice” were hypothesized to improve student executive function skills and were key components of the mindfulness-based intervention.

Comparing the SEL and Mindfulness-based Interventions

In the present study, both interventions were implemented using the sequence of lessons outlined by the respective curriculums for a total of 11 sessions, the first was an introduction session not specific to the curricula, the remaining 10 sessions were based on the sequence of lessons outlined by Second Step and MindUP respectively (see Table 3.2). The active ingredients in the social-emotional learning intervention were the skills-based lessons using picture cards which instructed students on the skills for learning as well as the “Brain Builder” games. The active ingredients for the mindfulness-based intervention, which are distinct from the active ingredients in the SEL intervention, were the lessons focused on understanding the parts of the brain and paying mindful attention to each of the five senses and the inclusion of the “Core Practice” (mindful meditation through “belly breathing”). To isolate the described active ingredients in each curriculum, the structures of both interventions were similar (see Appendix A).

Control Group

The structure of all kindergarten students’ daily schedule includes a 70 to 80 minute block in which students work on online learning programs (OLPs) in the computer lab. Students not participating in the EF intervention remained in the computer lab for the full block and completed OLPs and participated in any academic interventions they were assigned to. The OLPs involved online reading and math curricula and activities and did not explicitly teach social skills or target executive function skills. The computer lab teacher did not have access to the lessons or materials which were included in either of the social-emotional learning or mindfulness-based intervention groups. While the computer lab teacher was aware of which students were attending the intervention, the teacher did not know which students were assigned to each specific intervention group (social-emotional learning and mindfulness-based). Students attended their computer lab class every day for approximately 80 minutes, four days a week, and 70 minutes one day per week. Students were pulled from class to attend their EF intervention for 20 to 30 minutes out of the 90-minute block, one to two times per week during the nine weeks of intervention. From anecdotal evidence and discussion at the school, it was noted that the control classroom (computer lab) teacher sometimes struggled with classroom management and maintaining a positive classroom environment. This was evidenced by the teacher sometimes instructing students to take class-wide timeouts and put their “heads down” at their desks when the classroom became “too noisy” for the teacher, this punitive measure of “heads down, voices off” was sometimes observed as it was occurring when students were returning to class from the intervention conditions. On other occasions the classroom environment could be observed with a majority of the students working independently on computers to complete assigned online learning program activities related to math and reading, during these times there was little interaction between the teacher and students, as the goal was monitoring the classroom as students worked independently.

Fidelity

Fidelity assessment systems should match the scope of the study (Feely et al., 2018), as this is a preliminary study, the goal was to review at least 25% of the captured lesson videos for fidelity, measured as adherence to the components of the lesson plan. A fidelity checklist was created for both the social-emotional learning and mindfulness-based interventions which matched the lesson plan template. Lessons were videotaped of each group throughout the study so that fidelity checklists could be completed by outside observers on a sampling of lessons. The introduction session was not checked for fidelity as it established routines, but was not specifically aligned to either intervention approach. For the mindfulness-based intervention, 27 videos were available and for the SEL intervention, 27 videos were available. Two videos per intervention approach (mindfulness and SEL) were randomly selected for training and an additional two videos were randomly selected to establish interobserver agreement (IOA, measured as exact agreement). The initial observer training was conducted and was approximately an hour in length. The initial training session provided the observers with relevant information about the intervention approaches, lesson plans, and the protocol for rating. Both intervention approaches followed scripted lesson plans with six consistent lesson components, the observer rated whether each lesson component occurred with a “1” if the element was observed or “0” if the lesson element was not observed. After completing ratings for two training videos from each intervention and reaching agreement about the lesson ratings, the observers in training were instructed to independently watch two more videos of each intervention approach. Interobserver agreement was then calculated using the exact agreement method on two videos from each intervention approach. Exact agreement was used as the style of agreement to ensure ratings were identical on each lesson component, all three of us agreed 100% of the time, which exceeded the recommended target of 90% agreement (Feely et al., 2001). Each of the trained observers then independently reviewed half of the remaining videos. The randomization process for intervention videos was stratified by intervention type and intervention cluster such that for each intervention two videos were randomly selected from each of the four intervention clusters (resulting in 8 videos coded independently per intervention approach), this brought the total number of videos reviewed for fidelity to 12 (for each intervention), equating to 44% of the total lesson videos available being reviewed for fidelity, thus exceeding the stated goal of reviewing 25% of the lessons. The mindfulness lessons reviewed, demonstrated 100% fidelity to the intervention lesson plans and the SEL lessons demonstrated 99% fidelity to the lesson plans. Of the 12 videos rated, the average lesson length for the mindfulness-based intervention was approximately 21 minutes in length and the average lesson length for the SEL intervention was approximately 20 minutes. A summary of the fidelity analysis results are reported in Table 3.3.

Table 3.3
Results of Fidelity Analysis

	Mindfulness-based	SEL
Lessons Conducted	40 (4 groups x 10 sessions)	40 (4 groups x 10 sessions)
Videos Available	27	27
# of Videos Reviewed	12 (44%)	12 (44%)
Observer Reliability-IOA	100%	100%
Average Fidelity Rating	100%	99%
Average Lesson Length	21 minutes	20 minutes

Measures

EF was measured at three time points: pre-intervention (T1), immediately following intervention (T2), and at the end of the school year (T3) using the Minnesota Executive Function Scales (MEFS; see Table 1). Additionally, academic achievement in math and reading was measured via the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP®). NWEA data was collected by school staff, as scheduled by the school, at two time points, beginning of year (T1) and end of year (T3; see Table 1).

EF Measure. The Minnesota Executive Function Scales (MEFS) was used to measure EF skills at pre-test (T1), post-intervention (T2) and at the end of the school year (T3). The MEFS is an adaptive card-sorting task which is completed on a tablet device which measures students executive function skills through a series of virtual tasks with directions increasing in difficulty as the student advances to higher levels. The MEFS provides a single score for EF skills, as students are engaging their working memory, cognitive flexibility, and inhibitory control simultaneously throughout the MEFS tasks. This measure aligns with the unitary construct of EF skills which has been deemed most appropriate for children age 6 years old. The MEFS has been normed on a representative sample of 7,410 typically developing children ranging from age 2-13 as well as 553 adults (Carlson & Zelazo, 2014). The MEFS has shown high retest reliability (ICC= .93). Convergent validity has also been demonstrated with this measure as student performance on the MEFS is significantly correlated with performance on other commonly used EF measures such as the Head-Toes-Knees-Shoulders (HTKS) task (.77), EF Touch (.73), and the NIH Toolbox DCCS (.64; Carlson, 2017).

Direct measures, or performance-based tasks (i.e., highly structured EF tasks conducted during a testing session in an emotionally neutral setting) are considered the “gold standard” of EF skill assessment (Zelazo et al., 2016). The MEFS was administered one-on-one using an iPad by myself. Internet access was necessary to use the MEFS app and to upload student data. I was certified in MEFS administration by Reflection Sciences. Activities completed for certification included completing an online training, submitting a practice video administering the assessment, and passing an assessment. The administration of the MEFS takes approximately four to five minutes per child.

Academic Measures. The Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) assessment is a nationally norm-referenced, computer-based assessment which students take as a part of the school’s assessment battery. The NWEA MAP math and reading achievement data collected at the beginning of the year (BOY) served as pretest academic measures and the T3 data provided end of year (EOY) academic achievement data. The NWEA MAP assessments are adaptive, online assessments which usually have 40 to 50 questions per subject area. Marginal reliability estimates for the NWEA MAP for Primary Grades in reading and math have been reported for kindergarten students as .0.949 and 0.918 respectively (NWEA, 2011). NWEA cites concurrent validity estimates greater than .80 (as cited in Klingbeil, D. A., McComas, J. J., Burns, M. K., & Helman, L., 2015).

Analysis

To maintain the integrity of random assignment, the analysis was conducted using an intent to treat (ITT) framework, thus all students were analyzed based on their original assignment to condition rather than a condition that they were later switched to, this impacted nine students' condition assignment for analysis (WWC, 2020). To answer both research questions multiple regression was used and dummy variables were included in the regression models for the intervention conditions (mindfulness-based and SEL) with the control group as the reference group. Effect sizes were calculated using Hedge's *G* for within group effects. An effect size comparing the intervention group to the control condition was also calculated by taking the mean pre-posttest change in the treatment group and subtracting the mean pre-posttest change in the control group and dividing by the pooled pretest standard deviation (Morris, 2008).

Results

Assumption Checking

Regression analyses were used to analyze results and answer both research questions. To determine if the data could be analyzed using multiple regression, the assumptions underlying this technique were checked. The assumption of linearity was met by visually inspecting scatter plots of Time 2 (T2) EF against beginning of year (T1) EF as well as against student age. The independence of residuals was assessed by checking Durbin-Watson statistics, the results were close to 2 on all regressions, indicating this assumption is met (2.105 for Time 2 EF, 1.873 for T3 EF, 2.26 for math, and 1.65 for reading). No cases were identified during initial analysis which had standardized residuals greater than ±3 for regressions of EF. Visual inspection of a plot of standardized residuals versus standardized predicted values were relatively even in spread and did not reveal any funneling, indicating that the assumption of homoscedasticity was met. Residuals were normally distributed as assessed by visual inspection of a normal probability plot.

Adjustments for Clustering

The present study design is most accurately described as a partially-nested RCT with blocking (Lohr et al., 2014). The interventions (mindfulness and SEL) each occurred at four different "sites" and these created unique intervention clusters, four intervention clusters per intervention for a total of eight clusters. All students were nested in classrooms, and intervention students were then also nested in intervention clusters, while control group students were not considered nested in their control condition (thus the control group students are partially nested, while the intervention students have two levels of nesting to consider). The present study had eight intervention clusters, which can be considered a relatively small number of clusters and thus it was important to weigh the options available for analyzing data with few clusters (e.g., McNeish & Stapleton, 2016). The standard error estimates are likely to be too small if the clustering is not accounted for in some way, thus it was proposed that the standard error estimates of regression coefficients be multiplied by the DEFT, which is the square root of the unconditional design effect (McNeish & Stapleton, 2016). The DEFT value measures the degree to which the standard error of the mean is inflated due to the clustered nature of the data compared to data from a simple random sample, “a DEFT of 2 means that the standard error will be twice as large in a model that accounts for cluster than in a comparable model that ignores cluster” (McNeish & Stapleton, 2016).

In order to examine the level of variability between classrooms and intervention clusters and to calculate the design effect, intraclass correlation coefficients (ICCs) were calculated as well as subsequent DEFT values. The ICC for classrooms at pre-test EF skills (as measured by the MEFS) was 0.023. The ICCs for classrooms on beginning of year (BOY) Math achievement (as measured by the NWEA MAP) was 0.057, and the ICC for classrooms BOY Reading Achievement (as measured by the NWEA MAP) was 0.0006. These values indicate low variability between classrooms on initial EF and academic achievement measures, thus subsequent analysis did not include classroom level nesting in the model.

The ICCs for intervention clusters at pre-test EF skills was 0.174. The ICCs for intervention clusters on BOY Math achievement was 0.143, and the ICC for clusters BOY Reading Achievement (as measured by the NWEA MAP) was 0.15. These values indicate low variability between clusters on initial EF and academic achievement measures, however the ICCs at the cluster level were greater than the ICCs at the classroom level therefore the pre-test and BOY ICCs were used to calculate DEFT values to adjust the standard errors of the subsequent regression models. The cluster level DEFT value for pre-test EF was 1.36, and the BOY academic achievement Math and reading DEFT was 1.30 and 1.31, respectively. These DEFT values were used to adjust the standard errors in the subsequent regression analysis.

Baseline Equivalence

The demographics table (Table 3.4) shows that the average age of students and the gender balance was similar across all conditions. ICCs can range from 0 to 1 and values closer to 0 indicate low variability between the means of the different groups, thus the previously reported ICCs indicated low variability between classrooms and clusters on pre-test measures of EF skills and BOY academic achievement. These calculations were used as indications of baseline equivalence between the groups being compared.

Table 3.4

Study 1 Demographic Information and Descriptive Statistics, Mean (Standard Deviation)

	Control	n	Mindfulness	n	SEL	n	All	N
Gender (Male)	22	44	13	23	11	24	48	91

Age, Months	65.43 (4.37)	44	65.26 (4.9)	23	65.58 (3.7)	24	65.43 (4.3)	91
EF (T1)	47.64 (10.0)	44	45.04 (12.6)	23	42.54 (9.4)	24	45.64 (10.7)	4
EF (T2)	50.14 (15.2)	42	52.64 (15.9)	22	50.00 (10.6)	23	50.74 (14.2)	87
EF (T3)	56.94 (19.0)	32	59.73 (14.0)	22	52.40 (10.5)	20	56.54 (15.7)	74
Math BOY	133.23 (9.3)	43	132.91 (9.8)	23	131.25 (8.5)	24	132.62 (9.2)	90
Math EOY	164.00 (15.0)	40	167.90 (13.6)	21	166.59 (12.7)	22	165.67 (14.0)	83
Reading BOY	138.30 (12.2)	43	136.87 (7.9)	23	137.00 (8.6)	23	137.60 (10.3)	89
Reading EOY	159.45 (13.9)	40	160.10 (9.5)	21	160.59 (14.3)	22	159.92 (12.9)	83

Note. BOY= Beginning of Year, EOY= End of Year

Research Question #1 Results

To answer the first research question, “Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on EF skills over time, immediately following the intervention (T1 to T2)?” multiple regression was used to regress Time 2 EF on Time 1 EF, student age, and intervention condition. Intervention condition specific dummy variables were created to describe which condition the student experienced. Dummy variables were included in each regression model for intervention conditions (mindfulness and SEL) with the control group as the reference group. In the models examining EF skills, child age was including in the model as age explained some of the variance which was not explained by condition or pre-test score. Each condition was entered as a variable and dummy coding (“DV”) was utilized to reflect intervention condition. The regression equation can be expressed in the following form:

$$T2.EF_i = \beta_0 + \beta_1 T1.EF + \beta_2 ChildAge + \beta_3 DV.Mindful + \beta_4 DV.SEL + e_i.$$

The model predicted a statistically significant amount of variance following the intervention on T2 EF skills, $F(4, 82) = 13.62$, $p < 0.005$, with an adjusted R squared of 0.37. This can be interpreted as the model explained 37% of the variance in posttest (T2) EF scores. When analyzing the main effects, the β weight for the mindfulness condition was 4.71 ($p = 0.249$), and the β weight for SEL condition class was 4.121 ($p = 0.314$), neither beta values were statistically significant. The β weight for T1 EF skills was 0.84 ($p < .001$), thus pre-test EF skills significantly predicted T2 EF skills. As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 3.5.

Table 3.5
Regression: Post-test (T2) EF

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	-2.18	19.06	-40.10	35.73	0.91		
EF, Pre-test (T1)	0.84	0.12	0.61	1.07	<.001	0.16	<.001
Age (Months)	0.19	0.28	-0.38	0.75	0.51	0.38	0.630
Mindfulness	4.71	2.99	-1.23	10.65	0.12	4.06	0.249
SEL	4.12	2.99	-1.82	10.07	0.17	4.07	0.314

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using Pre-test EF, DEFT = 1.36

Research Question #2 Results

To answer the second research question, “Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on academic achievement (math and reading) and EF skills over time, at end of year testing (T1 to T3)?” multiple regression was used to regress end of year (T3) EF on Time 1 EF, student age, and intervention condition. Multiple regression was also used to regress end of year (T3) math and reading achievement on beginning of year (T1) math and reading achievement and intervention condition (using dummy variables for condition). The regression equations can be expressed in the following forms:

$$T3.EF_i = \beta_0 + \beta_1 T1.EF + \beta_2 ChildAge + \beta_3 DV.Mindful + \beta_4 DV.SEL + e_i.$$

$$T3.Math_i = \beta_0 + \beta_1 T1.Math + \beta_2 .Mindful + \beta_3 DV.SEL + e_i.$$

$$T3.Reading_i = \beta_0 + \beta_1 T1.Reading + \beta_2 .Mindful + \beta_3 DV.SEL + e_i.$$

The end of year (T3) EF model predicted a statistically significant amount of variance on end of year EF skills, $F(4, 69) = 8.12$, $p < 0.005$, with an adjusted R squared of 0.28. This can be interpreted as the model explained 28% of the variance in students' end of year EF scores. When analyzing the main effects, the β weight for the mindfulness condition was 5.228 (p = 0.318), and the β weight for SEL condition class was -0.600 (p= 0.909), neither beta values were statistically significant. The β weight for T1 EF skills was 0.80 (p <.001), thus pre-test (T1) EF skills significantly predicted endo of year (T3) EF skills. As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 3.6.

Table 3.6
Regression: End of Year (T3) EF

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	10.38	24.41	-38.32	59.09	0.672		
EF, Pre-test (T1)	0.80	0.15	0.50	1.10	<.001	0.203	<.001
Age (Months)	0.13	0.36	-0.59	0.85	0.720	0.493	0.792
Mindfulness	5.23	3.82	-2.40	12.86	0.176	5.200	0.318
SEL	-0.60	3.83	-8.24	7.04	0.876	5.207	0.909

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using Pre-test EF, DEFT = 1.36

The end of year (T3) math model predicted a statistically significant amount of variance on T3 math scores, $F(3, 78) = 13.80$, $p < 0.005$, with an adjusted R squared of 0.321. This can be interpreted as the model explained 32% of the variance in end of year Math scores. When analyzing the main effects, the β weight for the mindfulness condition was 4.175 ($p = 0.309$), and the β weight for SEL condition class was 4.346 ($p = 0.285$), neither beta values were statistically significant. The β weight for BOY math achievement was 0.89 ($p <.001$), thus beginning of year (T1) math achievement significantly predicted end of year (T3) math achievement. As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 3.7.

Table 3.7

Regression: End of Year (T3) Math

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	45.96	18.86	8.41	83.51	0.017		
Math,(T1)	0.89	0.14	0.61	1.17	<.001	0.18	<.001
Mindfulness	4.17	3.14	-2.07	10.42	0.187	4.08	0.309
SEL	4.35	3.10	-1.84	10.53	0.166	4.04	0.285

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using BOY Math ICC, DEFT = 1.33

End of year reading (T3) was regressed on beginning of year (T1) reading, and intervention condition. The regression model was not statistically significant, $F(3, 77) = 1.691$, ($p = .176$). When three cases with standardized residuals greater than 3 were removed the regression was significant, $F(3, 74)= 5.497$, $p < .005$, with an adjusted R squared of 0.149. This can be interpreted as the model explained 15% of the variance in end of year reading scores. When analyzing the main effects, the β weight for the mindfulness condition was 3.325 ($p =$

0.374), and the β weight for SEL condition class was 1.840 (p= 0.621), neither beta values were statistically significant. The β weight for beginning of year (T1) reading achievement was 0.46 (p <.05), thus beginning of year reading achievement significantly predicted end of year reading achievement. As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 3.8.

Table 3.8
Regression: End of Year (T3) Reading

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	94.46	16.04	62.50	126.41	<.001		
Reading (T1)	0.46	0.12	0.23	0.68	<.001	0.15	0.003
Mindfulness	3.33	2.84	-2.33	8.98	0.245	3.72	0.374
SEL	1.84	2.83	-3.80	7.49	0.518	3.71	0.621

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using BOY Reading ICC, DEFT = 1.31

Effect Sizes

The primary outcome of interest in this study was immediate post-test (T2) EF scores. Effect sizes were calculated two ways: within groups effect size comparing pre and post-test EF scores (see Table 3.9) and group comparison effect sizes. The within group effect sizes for the mindfulness and SEL condition, comparing Time 2 and Time 1 mean scores can be considered in the medium effect size range, compared to a small effect for the control group (small = .20, medium = .50, large .80; Cohen, 1992). An effect size comparing each intervention group to the control condition was also calculated by taking the mean pre-posttest change in the treatment group and subtracting the mean pre-posttest change in the control group and dividing by the pooled pretest standard deviation (Morris, 2008). The group comparison effect size comparing the mindfulness-based intervention to control group was 0.47, 95% CI [-0.04, 0.98], and the effect size comparing SEL to control was 0.50, 95% CI [0.001, 1.01]. The comparisons between intervention and control conditions are also in the medium range (small = .20, medium = .50, large .80; Cohen, 1992).

Table 3.9
Within Group Effect Sizes, Pre to Post-test EF

Group	Time 1, Pre Test EF			Time 2, Post Test EF			Hedges G	95% CI	
	n	M	SD	n	M	SD		*LL*	*UL*
Control	42	47.74	10.26	42	50.14	15.2	0.169	-0.067	0.405
Mindfulness	22	45.05	12.9	22	52.64	15.9	0.509	0.044	0.975
SEL	23	42.39	9.6	23	50	10.63	0.735	0.315	1.18

Note. G= Hedge's g for within-group pre-post effect sizes; M= mean, SD= standard deviation, n= number; CI= confidence interval; LL= lower limit; UL= upper limit

Exploratory Analysis with High EF Cases Removed

Prior research has indicated that children with the lowest EF skills prior to intervention are most likely to benefit and demonstrate improvements in EF skills from interventions (e.g., Flook et al., 2010). Given this precedent and the small sample size of the present study, examination of the descriptive statistics of the sample was conducted to determine if there were any cases that were two standard deviations above the mean on Time 1 EF skills. When examining high and low cases from the data set, 4 "high" cases of pre-test (T1) EF which were greater than two standard deviations from the mean were identified and removed, while the low EF cases remained in the data set, as it was possible these would be the very students that would benefit most from the interventions. These four cases also demonstrated Cook's *D* values beyond the size-adjusted cutoff of 0.045 ($D_i > 4/(n-k-1)$; Fox, 2015). A secondary analysis was run to determine if these four high cases being removed would significantly change the findings. The cases were made up of three control students and one student from the mindfulness condition.

The Time 2 EF regression model with high EF cases removed, predicted a statistically significant amount of variance, $F(4, 78) = 11.26$, $p < 0.005$, with an adjusted R of 0.33. This can be interpreted as the model explained 33% of the variance in posttest EF scores. When analyzing the main effects, the β weight for the mindfulness condition was statistically significant (p=0.022) prior to adjusting the standard errors to account for clustering, after adjustment the beta was not significant ($p > .05$), β=6.73, ($p = 0.09$), and the β weight for SEL condition class was 4.816 ($p = 0.213$), neither beta values were statistically significant. As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 3.10.

Table 3.10

Regression: Post-test EF (T2), High EF Cases Removed

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	-9.52	18.36	-46.08	27.04	0.672		
EF, Pre-test (T1)	0.83	0.13	0.57	1.09	<.001	0.178	<.001
Age (Months)	0.30	0.27	-0.24	0.83	0.269	0.365	0.416
Mindfulness	6.73	2.88	0.99	12.47	0.022	3.919	0.090
SEL	4.82	2.82	-0.80	10.44	0.092	3.839	0.213

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using Pre-test EF DEFT = 1.36

Missing Data and Attrition

Missing data was handled using pairwise deletion. At post-test, the overall attrition rate for EF data collection was 4% overall, with differential attrition being less than 1% between conditions. At end of year testing, the overall attrition rate for EF data was 19%, with differential attrition between control and mindfulness conditions reaching 23%. According to the WWC standards, at post-test the attrition is tolerable, but at end of year testing the differential attrition may indicate the study had been compromised. At the end of year it was known that at least five students of the 91 in the study had been unenrolled from the school and its possible unenrollment or truancy might explain the missing data at the end of year.

Post-hoc Power Analysis

A post-hoc power analysis was conducted using G*Power (Faul et al., 2007). The estimated power with the present sample size of 86 (the number of complete cases included in the model at Time 2) and 4 predictors, for a small effect size of (f^2=.02) was equal to 0.61, which indicated a 40% chance that a type II error could occur in which a small effect size was present but was not detected. For a medium effect size (f^2= .15) power was equal to 0.81, indicating increased power and a high likelihood that a medium or large effect size would be detectable with the present sample size. Thus the present study was likely underpowered to detect a small effect, but had sufficient power to detect a medium to large effect if it was present. The results of the G*Power post-hoc analysis should be interpreted with caution as this program does not account for the clustering of students and assumes the data is from a simple random sample.

Discussion

Insights from Comparing Intervention Approaches

The present study sought to directly compare two intervention approaches to determine if one approach was more effective than the other in improving student EF skills at two time points (T2 an T3) and end of year academic achievement. The post-hoc power analysis provided indication that the sample size and analysis techniques were likely able to detect a medium to large effect size if this was present, but the study was under-powered to detect a small effect size. The reported regression results consistently indicated that the models which included pre-test scores and intervention condition were significant and were able to explain variance in student outcomes on EF skills and academic achievement, however, the beta values for each intervention condition did not demonstrate significance ($p < .05$) in any of the models. The beta value for the mindfulness-based intervention was closest to significance in the regression model for Time 2 EF when high cases were removed (see Table 3.9).

As for the effect sizes, the results in this study are similar in magnitude to those reported in other studies of EF interventions. Takacs & Kassai's (2019) meta-analysis of EF interventions, reported an average effect size of $g= .46$ for mindfulness practices, and in the present study the mindfulness-based intervention demonstrated an effect size of 0.50 when comparing pre and post-test results and an effect size of 0.47 when compared to the control condition. Takacs & Kassai (2019) reported an average effect size of $g=.30$ for interventions which are comparable to the SEL intervention. The SEL intervention in the present study exceeded the effect size reported in the 2019 meta-analysis, as the SEL intervention demonstrated an effect size of $g= 0.74$ when comparing pre and post-test results and an effect size of 0.50 when compared to the control condition.

The results highlight that the intervention students demonstrated differences in EF skills at post-test (T2) compared to control group students, but the degree to which one intervention is more effective than the other is less clear, with a regression model result seeming to slightly favor the mindfulness condition when high EF cases were removed ($\beta=6.73$, $p = 0.09$). It is here that the under-powered nature of this study may explain why the difference between the two interventions, if small but significant in nature, was not detected in the regression results.

As for the second research question and exploration of the possible impact of EF interventions at follow-up and end of year academic achievement, no beta values were significant, nor did they approach significance at the $p<.05$ level. Takacs & Kassai (2019) reported a small effect at follow-up across intervention studies ($g=0.18$) which was not replicated in the present study. The question of whether EF interventions can improve academic achievement continues to be debated with some researchers questioning whether EF interventions can also improve student achievement in subject areas such as math and reading (e.g., Jacob & Parkinson, 2015). A consideration which will be discussed in the "future directions" section of the paper is whether teacher quality in the subject areas should also be examined and accounted for in examining this research question.

Limitations

There are at least three limitations to the present study. First, the control condition students did not receive additional small group time and it is possible that students' improvements or change in EF skills and academic achievement was simply due to the participation in a small group intervention rather than a reflection of the content of either intervention. Second, the sample size was constrained by opportunities for school access and school size and thus this study was somewhat underpowered to explore the research questions of comparing three groups (SEL, mindfulness-based, control). Finally, school attendance data was not collected for students. Thus, any relation between general school attendance and EF skills or academic achievement could not be statistically controlled for. Absenteeism is an issue which can impact student achievement and could also explain some of the differences in EF skills and academic achievement demonstrated by students in the study, so not using school attendance as a covariate may fail to account for some differences.

Potential Contributions

Despite the limitations, the present study contributes to the literature in three significant ways. First, this study contributes by examining the effects of two short-term interventions (9 weeks) and provides in-depth information about both the dosage of intervention and fidelity to the intervention curricula; previous studies have examined a curriculum (e.g., PATHS, Second Step, MindUP) as it is implemented over the course of a school year but have collected little or no fidelity data. Implementing a year-long curriculum (sometimes with daily lessons or routines) also requires a large investment of time and resources from teachers and schools, but if it is possible that a lower dosage (1-2 times per week) intervention can promote improvement in student EF skills, schools may find it more feasible to include EF interventions in their general education classrooms. While the effect sizes post-intervention (Time 2) showed a pattern of improved EF skills for intervention students, it is possible the intervention duration was not long enough to significantly improve student EF skills at post-test or at the end of the year. I hypothesize that the intervention would need to continue to occur once per week or bi-weekly throughout the school year to see effects at end of year, as the present study did not see effects on end of year EF skills. The second contribution of this study is the strength of the EF measure used alongside the interventions. Direct measures, or performance-based tasks, such as the MEFS, are considered the “gold standard” of EF skill assessment (Zelazo et al., 2016). Although the standard has been established, many studies still rely on indirect measures (i.e., questionnaires) of EF skills. The use of a direct measure of EF (MEFS) rather than relying on indirect measures of EF, such as teacher or parent rating scales which may be more subjective in nature increases the likelihood that the data collected truly captures EF skills and not merely the attitudes and observations of a caregiver. Finally, childhood poverty and subsequent stress from living poverty is linked to lower EF skills (e.g., Haft & Hoeft, 2017). The present study occurred in a public school in a typically under-resourced community, thus the findings of the present study are likely to be relevant to schools with similar demographic profiles and may inform best practices for students who are at-risk for EF skill deficits. The results of the exploratory analysis when “High EF” cases were removed approached significance and replicate previous findings that students with low initial EF skills benefit the most from interventions (Flook et al., 2010). It seems providing a low cost, short-term intervention revealed a pattern of EF skill improvement for students in intervention conditions (when examining effect sizes compared to the control group), however the interventions described here may need modifications for students to demonstrate significant EF improvements in a future study (i.e., increased dosage or duration, improved curriculum, increased sample size).

Future Directions

Of broader interest, the results of the present study may inspire curiosity about why the mindfulness and SEL interventions did not have an effect on academic achievement, as has been demonstrated in other studies (e.g., Durlak et al., 2011). Beyond the possibility that the EF interventions were not in and of themselves effective, it is possible that teacher quality in the subject areas, such as in math and reading instruction, should be measured and documented as a possible further explanation of what conditions need to be in place for an EF intervention to also demonstrate effects on academic achievement. Put simply, if students participate in an effective EF intervention but do not consistently receive evidence-based instruction in the subject areas, it is possible no effect on academic achievement will be evident, as there is simply no substitute for effective instruction in the content areas (i.e., math and reading). EF interventions, which can include SEL interventions, may demonstrate effects on academic achievement, but it is possible teacher quality is also an essential factor that must be present for those results to occur.

The present study produced medium effect sizes at post-test on EF skills, following a short-term intervention (SEL and mindfulness). Worthy of exploration is whether it is possible to leverage the perceived strengths and benefits of each approach into a combined approach which might be termed "Mindfulness+ SEL." As the practitioner in the present study, it was notable which elements of the lesson were most engaging for students and which elements were also the most feasible to implement with a larger group of students (compared with what is most practical when working with a small group of students). Other studies of year-long curriculum tend to implement the approach whole-group with classrooms of students, it is possible that the intervention effectiveness is also increased by exposing all students to the skills and strategies, potentially improving the classroom environment in ways that enhance all students EF skills above and beyond what is possible when only a subset of students participate in an intervention. Taking an incremental approach, the combined approach could be tested with a whole classroom of students but could remain consistent in the dosage model tested in the present student (less than 20-minute sessions, 1 to 2 times per week).

Conclusion

This study provided an opportunity to pilot two intervention approaches in small groups to kindergarten students in order to determine if a short-term, small group intervention could have significant effects on EF skills. The results are promising when examining the effect sizes but neither intervention demonstrated effectiveness beyond the other, thus this experience led me to make two changes to the intervention: adjust the approach to reflect and leverage the strengths of both mindfulness and SEL instruction and increase the group size to whole group, rather than isolate the skill development to a subset of students. The outcomes and experience of piloting these interventions have led to the design and implementation of a combined approach “Mindfulness + SEL” which will be explored in Study 2.

Chapter 4: Study 2

Executive Function (EF) skills are considered the building blocks of learning as they underlie goal-directed behavior and provide students with the tools to manage impulsivity and make choices which facilitate reaching a goal or achieving a desired outcome (Griffin et al., 2016). EF skills are positively associated with academic and social success and are responsive to intervention (e.g., Diamond & Ling, 2016). The younger years have been suggested as a critical period for intervention while students' brains may be most malleable to change (Griffin et al., 2016). Thus, it has become important to researchers, policymakers, and practitioners to consider how EF interventions can potentially buffer risk factors for students living in the most vulnerable communities (Bierman & Torres, 2016). This is an especially important opportunity to consider as EF skill development can be delayed among children who grow up in poverty (Noble et al., 2007). Fortunately, students with low or poor initial EF skills (e.g., some students who are lower-income or some children with ADHD) generally benefit the most from intervention programming, thus interventions targeting EFs may be an avenue to reducing the achievement gap (Diamond & Lee, 2011).

EF Skills and Age

EF skills have been likened to the "air traffic control system" of the brain, where information is sorted and decision making is often rapidly occurring, similar to the ongoing "arrivals and departures" of planes at an airport (Center on the Developing Child at Harvard University, 2011). EF skills have been measured and subsequently grouped into three interrelated, yet distinct skill groups: cognitive flexibility, inhibitory control, and working memory (e.g., Griffin et al., 2016; Zelazo et. al, 2017). EF skills are related to intelligence and Rueda et al. (2012) states that, "transfer to intelligence after training of executive functions is relatively unsurprising given the interrelated nature of EFs processes and the fact that many common regions of the frontal lobe are recruited by cognitive demands involved in general intelligence and the various processed under the umbrella of EFs (Duncan and Owen, 2000; Duncan et al., 2000)" (p.193). It is important to understand the relationship between age, executive function development and the subsequent pairing with EF constructs. Latent variable analysis has been readily utilized to determine if EF skill groupings (i.e. cognitive flexibility, inhibitory control, and working memory) are distinct and should be measured using a one, two, or three factor model. In studies of children ranging in age from three to six, a unitary construct has been identified as the best fit (Hughes et al., 2009; Shing et al., 2010; Wiebe et al., 2007; Willoughby et al., 2012). It is hypothesized that the distinctions among EF domains begin to crystalize and are more distinctly measurable as students exit preschool contexts and advance to elementary and middle school (e.g., Shing et al., 2010). The unitary construct appears the most appropriate for young children and as such this framework will go on to inform the measures chosen for this study of young children's EF skills.

EF and Academic Achievement

Research has also highlighted the contribution of EF skills as they are distinct from IQ in predicting school adjustment (Masten et al., 2012). The predictive relationship between EF skills and academic achievement and school readiness has been documented (e.g., Cortés Pascual et al., 2019). Positive associations between EF skills and emergent literacy skills have been found beginning in preschool students, after controlling for language status, gender, age, and maternal education (Becker et al., 2014). In a meta-analytic review of the relation between EF skills and reading comprehension, a consistent and positive association was found across the age range of six to 17-year-old participants (Follmer, 2018). Deficits in kindergarten students' EF skills have been found to increase student risk for academic challenges across elementary school (e.g., Morgan et al., 2019). When these positive and longitudinal associations between EF skills and school success are reported in empirical research, often a call is made to focus on EF skills directly as a worthwhile target of intervention (e.g., Willoughby, Wylie, & Little, 2019; Zelazo et al., 2016).

Effective Interventions Targeting EF

A myriad of strategies and interventions intending to improve the executive function skills of children have been explored over recent years, including but not limited to: computerized training, aerobic exercise, martial arts, mindfulness, classroom curricula (Tools of the Mind, PATHS), and Montessori instruction (e.g., Diamond & Lee, 2011) In a recent meta-analysis, an overall a positive effect was found across all EF intervention studies (*g*=.30) and effects ranged in the categories of interventions from .12 to .46 (Takacs & Kassai, 2019). From this comprehensive meta-analysis, "providing new strategies of self-regulation" emerged as the category with the largest overall effect size and included the following subcategories: mindfulness practices (*g*=.46), biofeedback-enhanced relaxation (*g*= .93), and strategy teaching interventions (*g*=.30). "Strategy teaching" interventions were described by the authors as interventions which overtly taught students strategies of self-regulation; the PATHS program was one example and in other literature is described as a curriculum which promotes emotional and social competencies (Takacs & Kassai, 2019).

In a chapter dedicated to considering the early education programs and prevention strategies that may be most effective at improving EF skills of at-risk students, two approaches posited were "direct training and practice" and "promoting social-emotional learning"

(Bierman & Torres, 2016). The logic model supporting "direct training" is that similar to strength training in a sport or activity (Bierman & Torres, 2016), the "training" approach focuses on targeting the growth of neural circuits that support EF skills with the hope that subsequently strengthened circuits will increase EF skills and self-regulation (Posner et al., 2006). Social-emotional learning is posited as an approach to EF skill preventative intervention as it builds from research indicating that emotion regulation and social problem-solving skills can increase EF skills (Bierman & Torres, 2016). By making information about social skills and problem solving more accessible to students (e.g., facilitating schema development about common social exchanges) and providing concrete suggestions and guidance it is hypothesized that students improve their self-regulation and EF skills (Bierman & Torres, 2016)

Social-emotional Learning, Mindfulness and EF Skills

Social-emotional learning (SEL) has been identified as a possible intervention avenue for improving EF as it explicitly teaches a student about problem solving and emotion regulation (Bierman & Torres, 2016). SEL has been defined as "the processes of developing social and emotional competencies in children" and this learning can occur through direct social and emotional skills instruction and practice as well as through positive interactions and relationships between students and teachers (Collaborative for Academic, Social, and Emotional Learning, 2013). Principles for SEL interventions have been summarized in the acronym "SAFE" suggesting that lessons should be sequences, active, focused, and explicit; additionally SEL interventions are distinctively goal oriented and use an "outside-in" approach to train students in prosocial behavior explicitly (see Table 4.1). Social-emotional learning curriculums, such as PATHS (Promoting Alternative Thinking Strategies), have demonstrated positive effects on student EF skills (Bierman et al., 2008; Riggs et al., 2006). While SEL interventions have been identified as an approach for early EF intervention, further research is warranted using this approach with novel curricula (i.e., curricula besides PATHS) and with participants beyond the preschool age group.

Studies have also been conducted using mindfulness-based interventions which target EF skills (Flook et al., 2010; Flook, et al., 2015; Gallant, 2016; Thierry et al., 2016; Zelazo & Lyons, 2012). Mindfulness instruction is hypothesized to support the development of self-regulation by targeting top-down processing and simultaneously reducing bottom-up influences, such as anxiety, to promote students' attention and ability to problem solve in the moment (Zelazo & Lyons, 2012). Mindfulness trains the participant to focus and return attention when the mind has drifted (Flook et al., 2015). Principles for mindfulness-based interventions have been described as promoting "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (Kabat-Zinn, 1994) additionally mindfulness-based interventions are distinctively oriented toward building self-awareness of participants and use an "inside-out" approach to encourage awareness of inner emotions, thoughts and senses (see Table 4.1). The logic model for "direct training" interventions, cited by Bierman & Torres (2016), explains that targeting the growth of neural circuits can subsequently increase EF skills and self-regulation (Posner et al., 2006), mindfulness-based interventions include practices of meditation which may help to "train" and strengthen neural circuits.

Combining Mindfulness and SEL

With growing evidence to support the use of SEL and mindfulness-based interventions to target EF skills, calls have been made by practitioners and researchers to consider the efficacy of intervention approaches which combine the distinct but complementary components of each intervention (Brensilver, 2016; Lantieri & Zakrzewski, 2015). The overlapping goals of mindfulness and SEL instruction have been discussed increasingly in recent years and theoretical frameworks and empirical studies have been published which explore the possibility of pairing mindfulness and SEL intervention approaches (e.g., Feuerborn & Gueldner, 2019; Lawlor, 2016; Schonert-Reichl et al., 2015). One published study describes the implementation of a combined mindfulness and SEL program (M-SEL) in a Brazilian school, the study was conducted with 5th graders (N=132; Waldemar et al., 2016). The curriculum was developed using the CASEL skill sequence (i.e., skills such as "recognize and manage emotions") and the sessions began and finished with mindfulness exercises; the combined intervention approach (M-SEL) had a significant and positive effect on students' emotional health (Waldemar et al., 2016). Table 4.1 compares key elements of each type of intervention, SEL and Mindfulness-based.

Table 4.1

Comparison of Intervention Approaches' Principles and Possible Limitations

	SEL	Mindfulness-based
Principles for intervention approach	Provides lessons and activities that are: "SAFE- **S**equenced, **A**ctive, **F**ocused, **E**xplicit" (Collaborative for Academic, Social, and Emotional Learning, 2013).	Provides lessons and activities that promote: "paying attention in a particular way: on purpose, in the present moment and non-judgmentally" (Kabat-Zinn, 1994).
	"Goal-oriented" and specific about desired outcomes, such as: prosocial behavior, emotion regulation, school success (Brensilver, 2016)	Focused on "self-awareness" and self-regulation (Brensilver, 2016)
	"Outside-in" approach: the teacher trains students in a specific skill,	"Inside-out" approach: students are encouraged to become aware of their

	then practice occurs, students are expected to generalize the skill (Lantieri & Zakrzewski, 2015)	inner emotions, thoughts, and senses and thus become better able to regulate (Lantieri & Zakrzewski, 2015)
Possible Limitations of intervention as a "stand alone" approach	Students may learn the "right" language or the "right" behavior, but may be left without the self-regulation skills to help them process a strong feeling and act according to their knowledge of prosocial behavior	Students learn to self-regulate and use practices such as meditation and belly breathing, but students may not have strongly developed schemas to navigate specific social situations or understand school expectations if they are not taught explicitly

The Present Study

There have been several mindfulness-based interventions conducted with young children (McCatharn & Taboada-Barber, 2020; Takacs & Kassai, 2019). As well as social-emotional learning interventions conducted with young children (Durlak et al., 2011; Takacs & Kassai, 2019). However, no known studies with young children in the United States have strategically combined the key components of each of these intervention approaches into one intervention. Given that both intervention approaches share aims of supporting self-regulation, self-awareness, and EF skills, it may be efficacious to bring these two distinct, yet complementary intervention approaches together in one combined intervention. Each approach relies on moderately different principles and each intervention has unique limitations when conducted as a "stand alone" approach (see Table 4.1). By combining both interventions, I hypothesize that the approaches will complement one another and provide a more robust approach to improving student EF skills.

The present study builds upon Study 1 by combining the two previously compared interventions: a social-emotional learning intervention (based on the Second Step curriculum) and a mindfulness-based intervention (based on the MindUP curriculum). In the present study the SEL intervention was combined with the mindfulness-based intervention to leverage the most active ingredients in both studies to create a more robust intervention targeting EF skills and to overcome the hypothesized limitations that may exist when the interventions are used alone (see Table 4.1).

In a synthesis of mindfulness-based interventions targeting EF in young children, four out of nine included studies had sample sizes less than 35 students and only four of the nine studies had a randomized design (McCatharn & Taboada-Barber, 2020). Four of the studies had a majority Caucasian student population. The present study has an intervention group sample size of 97 kindergarten students and a control group sample size of 44 students (N= 141), the study participants are majority African American and attend a school in an under-resourced community. The present study was implemented in 11 sessions and was conducted within the general classroom environment with a whole classroom of students present, thus scaling up from Study 1 to be introduced as what may be considered a “Tier 1” or primary prevention program which is a part of the universal core instructional program of the school (Fuchs & Fuchs, 2007). By examining the effects of 11 lessons taught over a 6-week period, using a combination of two approaches (social emotional learning and mindfulness-based intervention), insight may be provided about the threshold of intervention required to see measurable improvement in student EF. The present study utilized a historical cohort control group design which facilitated comparing the combined Mindfulness + SEL intervention against the control group (n=44) from Study 1 in order to examine the efficacy of the new intervention at improving the EF skills of kindergarten students.

Research Questions

In the present study, I examined the effects of a Mindfulness + SEL intervention compared to a historical cohort control group (Study 1), during 11 lessons of intervention with classrooms of kindergarten students in an urban setting. Two main research questions guided this study: "Is there a significant difference between groups (Mindfulness + SEL intervention and control) on EF skills over time (T1 to T2) and (T1 to T3)?" and "Is there a significant difference between groups (Mindfulness + SEL intervention and control) on academic achievement (math and reading) over time, at end of year testing (T1 to T3)?" (See Table 4.2).

Table 4.2

Study 2, Design and Testing time points

Condition, Sample Size	Pre-test (T1) Measures	Intervention	Post-intervention (T2) Measures	End of Year (T3) Measures
Mindfulness + SEL (n=97)	EF Math Reading	Mindfulness + SEL Intervention	EF	EF Math Reading
Study 1- Historical Control (n=44)	EF Math Reading	Business-as-usual	EF	EF Math Reading
Time of Year	*October*	*Oct-Dec.*	*December*	*May/June*

Hypotheses

Previous research has highlighted the usefulness of social-emotional curriculum at increasing executive function skills (e.g., Bierman et al., 2008; Riggs et al., 2006), and studies examining mindfulness-based approaches to increasing executive function have also shown effectiveness (e.g., Flook et al., 2015; Thierry et al., 2016). Therefore, I hypothesized that the students in the Mindfulness + SEL intervention group will demonstrate higher EF skills after intervention (T1 to T2) compared with control group students. As EF skill development is also predictive of academic success, I also hypothesize that students in the intervention group may demonstrate academic growth beyond their peers in the control group at end of year testing (T1 to T3). Previous research has indicated that change in EF can be sustained post-intervention, so I hypothesize that students in the intervention condition may demonstrate sustained increased EF skills at year end (T1 to T3).

Method

Design

Among quasi-experimental designs in education research, historical cohort control group designs are considered an especially advantageous model as this design can reduce non comparability of treatment and control conditions (Walser, 2014). Shadish, Cook, and Campbell (2002) designate the word "cohort" to indicate a successive group that goes through a process, in this case cohorts pass through the same elementary school as kindergarten students. Cohorts are deemed especially useful as a control group when a cohort experiences a treatment that an earlier cohort does not, in this case an earlier cohort did not receive the EF intervention (Shadish, Cook, & Campbell, 2002). The present study used a historical cohort control design, with the students from Study 1 (n=44) who were in the control condition serving as the control for the intervention students in the subsequent year where Study 2 (the present study) took place. The setting for Study 1 and Study 2 was the same school. The control group students from Study 1 worked on online learning programs (OLPs) during the computer lab block, in Study 2 all students in kindergarten participated with their classmates 1 to 2 times per week in a whole-class intervention led by the researcher, while their classroom teacher was present for the 11 sessions. During Study 1 and Study 2 the school had 4 kindergarten classrooms, in Study 2 all students in the classroom participated in the Mindfulness + SEL intervention when it occurred.

Setting and Participants

This study took place in a public charter school in the Mid-Atlantic United States, the same school that was the setting of Study 1. The student population is 95.9% Black, Non-Hispanic. The school qualifies for the Community Eligibility Provision (CEP), which allows all students to receive free lunch and breakfast. The school had students enrolled in grades kindergarten through fourth grade at the time of this study. The kindergarten grade level was organized with students in four classes, each with approximately 26 to 27 students. The school utilized a departmentalized, rotational model so students rotated between multiple teachers throughout the school day and did not have a single homeroom teacher. Two classes had one humanities teacher and two classes had a different humanities teacher. All four classes of students had the same math teacher and all four classes also shared the same computer lab teacher. The intervention sessions in this study all occurred during the computer lab class which each class in the grade level attended daily.

All kindergarten students at the school were sent home with passive consent forms to allow any parents to withdraw their student's data from being included in the study (one form was returned and that students' data was not included in the study); the intervention occurred for all students as a part of the universal curriculum during the computer lab class. There were 104 students across the four kindergarten classes which were included in the Mindfulness + SEL intervention, however initial (T1) EF data was only collected for 97 students. Two students were not able to complete the EF measure due to severe disabilities; three students' data was excluded as they had been retained in kindergarten from the previous school year and overlapped with Study 1 participants. One student was not in attendance during the testing window, and one student's data was excluded due to the parent returning the passive consent form. The intervention participants were kindergarten students (48 females, 49 males) and 99% of participants identified as Black/African (race/ethnicity data was missing for four out of 97 students). The mean age of students was 5.5 years old. Six students who were classified as students receiving special education services and had Individualized Education Programs (IEPs), were included in the study.

Procedures

Letters were sent home with each child informing parents of the study and the parents' right to have their child's data excluded from the study by signing a form and returning it to their child's teacher. One form was returned, and that student's data was excluded from the study. Two students with severe cognitive disabilities were excluded from formal participation and inclusion in the data collection process but were encouraged to participate with their classmates during the whole group sessions along with their personal aide who was present to support them during the lessons. All eligible students in each kindergarten class were assessed using the Minnesota Executive Function Scales (MEFS) measure as a part of the study procedures (see below in "Measures" section for further description). All students who were in attendance during the first testing window (T1) and were able to complete the assessment were eligible for inclusion in the post-test EF data collection (T2) and end of year EF testing (T3; see Table 1).

The students in the historical control group from Study 1 were randomly assigned within the 4 kindergarten classrooms during the prior school year. Randomization in Study 1 occurred within classrooms and resulted in 24 students participating in the SEL intervention across classes, 24 students participating in the mindfulness-based across classes, and 44 students in the control group across classes.

Interventionist. I conducted the Mindfulness + SEL intervention within my role as a learning specialist at the school. I was employed in the role of learning specialist during the prior two school years and had approximately five years of prior classroom teaching experience and a dual certification in elementary and special education at the time of this study. I prepared for the intervention lessons by using the lesson plans from Study 1 and scripting and transitioning the lesson materials into a slide format to project on a screen in the classroom (See Figure 4.1 and 4.2, Appendix C). The original templates for both approaches are referenced in Chapter 3, see Appendix B.

Duration and location. The Mindfulness + SEL intervention lessons took place over a 6 week time period, and included 11 lessons which lasted an average of 14 minutes each (lesson length varied based on factors such as student engagement and lesson components). When all students in a single kindergarten class attended sessions, the maximum group size was 27 students. The intervention occurred in the computer lab classroom which had a large square carpet for students to sit on during the intervention lesson, the classroom was also equipped with a large television screen on which the lesson slides were projected so all students could view the visual aids and I (the interventionist) could following along with the slides as I taught the lessons. Additional materials for the Mindfulness + SEL intervention included a dog puppet from the Second Step curriculum, the “Rules of Listening” poster, the brain visual from

MindUP, a “brain jar” (a large plastic bottle full of glitter and beads which is shaken up to simulate “settling down”), and the slide deck which was created and projected during every session. Groups were conducted in the presence of the computer lab teacher who remained in the classroom during sessions, additionally several para-educators were occasionally present for the lessons to support students with severe disabilities.

Table 4.3

Study 2 *Mindfulness + SEL Intervention Lesson Sequence*

Lesson	Study 2 Lesson Sequence	Lesson Content and Components Overview
1	Learning to Listen (SEL- Second Step)	• Students learn the rules of listening: “Eyes Watching, Ears Listening, Voice Quiet, Body Still” (this practice is repeated in all subsequent sessions)
2	How the Brain Works (Mindfulness-based-MindUP)	• Rules of Listening • Students learn the parts of the brain (prefrontal cortex - “wise leader”, hippocampus- “memory saver”, amygdala- “security guard” • Core Practice of mindful meditation introduced briefly (this practice is included in all subsequent sessions)
3	Mindful v. Unmindful (Mindfulness-based-MindUP)	• Rules of Listening • Review Parts of Brain • Engage: students learn what it means to be “mindful” v. “unmindful” • Core Practice (1 min)
4	Focusing Attention (SEL- Second Step)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Story Card: Focusing Attention • Brain Builder Game • Core Practice (1 min)
5	Mindful Core Practice (Mindfulness-based-MindUP)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Core Practice with bell

6	Following Directions (SEL-Second Step)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Story Card: Following Directions • Brain Builder Game • Core Practice
7	Mindful Listening (Mindfulness-based - MindUP)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Engage: students learn what it means to be listen mindfully to a variety of sounds • Core Practice
8	Self-Talk (SEL- Second Step)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Story Card: Self-Talk • Brain Builder Game • Core Practice
9	Mindful Movement (Mindfulness-based- MindUP)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Engage: students learn what it means to be move mindfully and notice their heart rate • Core Practice
10	Being Assertive (SEL- Second Step)	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful • Story Card: Being Assertive • Brain Builder Game • Core Practice
11	Review and Closure	• Rules of Listening • Review Parts of Brain, Mindful/Unmindful, Story Card lessons • Core Practice

Mindfulness + SEL Intervention

The intervention content for this study blended two intervention approaches (see Table 4.1) into one novel intervention curriculum (see Table 4.3). This lesson sequence was developed by taking lessons learned from Study 1 implementation and hypothesizing that combining elements from each approach, SEL and mindfulness, would create a curriculum with greater effectiveness than either approach on its own. The curriculum in Study 2, Mindfulness

+ SEL, brings together the direct skills teaching and connections to the school setting present in the SEL curriculum (e.g., the use of story cards featuring students at school and instruction around basic social and academic skills such as listening, focusing attention) with the reflectiveness and self-regulation practices of the mindfulness-based approach. I hypothesized that a balance of direct social skills training along with self and environmental awareness training via mindfulness will create a more effective curriculum than one which relies primarily on mindfulness strategies or SEL strategies alone (see Table 4.1).

Mindfulness-based Intervention Content. The mindfulness-based intervention content which comprised the lesson focus for Lessons 2, 3, 5, 7, and 9, was adapted from an existing curriculum, MindUP Step (see Table 4.3). MindUP has been previously proven effective in increasing preschoolers' EF skills (Thierry et al., 2016), and in the present study the "pre-kindergarten to grade 2" edition was used. The lesson topics in the mindfulness-based intervention which were most focused on understanding the brain, mindfulness, and the senses, were included in this combined intervention approach. For this combined approach, the sense of hearing or "listening" (Lesson 7) and mindful movement (Lesson 9) were include in the whole-class intervention as these were two of the sensory activities that were deemed most replicable in a whole group setting (e.g., compared to conducting a mindful tasting activity which would likely be challenging to manage with a whole class of students). The MindUP curriculum explicitly teaches students the parts of the brain and how the brain functions which subsequently provides students with insights into their own minds and behaviors and increases their self-awareness (MindUp Manual, 2011). The lesson sequence (see Table 4.3) incorporated teaching the "core-practice" of mindfulness meditation beginning in Lesson 2 and continued to include the practice for the remaining sessions (see Table 4.3). By teaching and repeatedly practicing the "Core Practice" of mindful meditation via belly breathing and attentive listening throughout the sessions, students are hypothesized to increase self-regulation. Both the content of the lessons (e.g., parts of the brain, sensory lessons) and the inclusion of the "Core Practice" were hypothesized to improve student executive function skills and were key components of the Mindfulness-based intervention in Study 1, thus these elements were included in the combined intervention approach in Study 2. A sample of one of the Mindfulness focused lesson slide decks, within the Mindfulness + SEL intervention, "Lesson 3: Mindful and Unmindful" is included as Figure 4.1 (see Appendix C).

SEL Intervention Content. The social emotional learning intervention content which comprised the lesson focus for Lessons 1, 4, 6, 8, and 10, was adapted from Second Step, a social-emotional learning curriculum which focuses on explicitly teaching social skills (see Table 4.3). Second Step is a curriculum with editions created for use with specific age groups, in the present study the kindergarten edition was used. The lesson topics in the SEL intervention which were most focused on self-regulation and positive classroom behaviors such as "focusing attention" and "listening" and explicitly teaches strategies such as "self-talk" and how to address problems and share personal feelings with others, were included in this combined intervention approach. The Second Step curriculum includes picture cards featuring a picture of a child and a story to share with the students which illustrates the lesson focus for the session, these cards were reproduced on a slide which could be projected for the whole class to view more easily. The "Brain Builders" were included in this combined intervention and are described as game-like exercises "which work to build students' attention, working memory, and inhibitory control" (Committee for Children, 2011). Both the content of the skills-focused, picture card based lessons and the inclusion of the "Brain Builders" activities were hypothesized to improve student executive function skills and were key components of the SEL intervention in Study 1, thus these elements were included in the combined intervention approach in Study 2. A sample of one of the SEL focused lesson slide decks, within the Mindfulness + SEL intervention, "Lesson 4: Focusing Attention" is included as Figure 4.2 (see Appendix C).

Control Group

The Study 1 control group served as a historical control group for Study 2. During Study 1, the structure of all kindergarten students' daily schedule included a 70 to 80 minute block in which students worked on online learning programs (OLPs) in the computer lab. Students not participating in the EF interventions during Study 1 remained in the computer lab for the full block and completed OLPs and participated in any academic interventions they were assigned to. The OLPs involved online reading and math curricula and activities and did not explicitly teach social skills or target executive function skills. The computer lab teacher did not have access to nor was she familiar with the lessons or materials which were included in either of the social-emotional learning or mindfulness-based intervention groups during the fall of the school year. Students attended their computer lab class every day for approximately 80 minutes, four days a week, and 70 minutes one day per week.

During the back-to-back of the school years in which Study 1 and the present study (Study 2) occurred, the same principal led the school. Anecdotal description of differences in the kindergarten teaching staff from year 1 (Study 1, control group) to year 2 (the present study) would include noting that a teacher who had previously served as an assistant teacher, became the math teacher in year 2 and two new reading teachers were employed as well as a new computer lab teacher. These changes in staffing meant that some students in Study 2 had teachers with fewer years of experience than some of the control group students from Study 1. No new initiatives incorporating the intervention approaches of social-emotional learning or mindfulness were implemented at the school during either school year.

Fidelity

As this is a preliminary study, the goal was to review at least 25% of the captured lesson videos for fidelity, measured as adherence to the components of the lesson plan. Thirty-seven videos of the Mindfulness + SEL intervention were available for review. Two videos were randomly selected for training and an additional two videos were randomly selected to establish interobserver agreement (IOA, measured as exact agreement). Two researchers were trained to complete the fidelity ratings. The initial observer training was conducted and was approximately an hour in length. The initial training session provided the observers with relevant information about the intervention approach, lesson plans, and the protocol for rating. The intervention followed scripted lesson plans presented on digital slides (Google Slides), projected on a screen in the classroom. A template was created alongside the slide deck, so the observers could check if each slide and lesson component occurred during the lesson on the video. The observers rated whether each lesson component occurred with a “1” if the element was observed or “0” if the lesson element was not observed. After completing ratings for two training videos and reaching agreement about the lesson ratings, the observers were instructed to independently watch two more videos of each intervention approach. Interobserver agreement (IOA) was then calculated using the exact agreement method on the two videos. Exact agreement was used as the index of reliability to ensure ratings were consistent on each lesson component, only one element in one lesson resulted in an observer disagreement, and the calculated IOA rate was 97.92%, which exceeded the recommended target of 90% agreement (Feely et al., 2001). Each of the trained observers then independently reviewed four more videos. The randomization process for intervention videos was stratified by classroom cluster such that for each classroom two videos were randomly selected (resulting in eight videos to be coded independently), this brought the total number of videos reviewed for fidelity to 12 (two videos for training, two for IOA calculations, eight rated independently, split between two observers), equating to 32% of the total lesson videos available being reviewed for fidelity. As assessed through observer ratings, the Mindfulness + SEL intervention demonstrated 100% fidelity to the intervention lesson plans. Of the 12 videos observed and rated, the average lesson length for the intervention was approximately 14 minutes in length (see Table 4.4).

Table 4.4
Results of Fidelity Analysis

	Mindfulness + SEL Intervention
Lessons Conducted	44 (4 classes x 11 sessions)
Videos Available	37
# of Videos Reviewed	12 (32%)
Observer Reliability- IOA	97.92%
Average Fidelity Rating	100%
Average Lesson Length	14 minutes

Measures

EF was measured at three time points during Study 1 and Study 2: pre-intervention (T1), immediately following intervention (T2), and at the end of the school year (T3) using the Minnesota Executive Function Scales (MEFS; see Table 2). Additionally, academic achievement in math and reading was measured via the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP®). NWEA data was collected by school staff, as scheduled by the school, at two time points beginning of year (BOY, T1) and end of year (EOY, T3).

EF Measure. The Minnesota Executive Function Scales (MEFS) was used to measure EF skills at pre-test (T1), post-intervention (T2) and at the end of the school year (T3). The MEFS is an adaptive card-sorting task which is completed on a tablet device which measures students' EF skills through a series of virtual tasks which increase in difficulty as the student advances. The MEFS provides a single score for EF skills, as students are engaging their working memory, cognitive flexibility, and inhibitory control simultaneously throughout the tasks. The MEFS aligns with the unitary construct of EF skills which has been deemed most appropriate for children age 6 years old. The MEFS has been normed on a representative sample of 7,410 typically developing children ranging from age 2-13 as well as 553 adults (Carlson & Zelazo, 2014). The MEFS has shown high retest reliability (ICC= .93). Convergent validity has also been demonstrated with this measure as student performance on the MEFS is significantly correlated with performance on other commonly used EF measures such as the Head-Toes-Knees-Shoulders (HTKS) task (.77), EF Touch (.73), and the NIH Toolbox DCCS (.64; Carlson, 2017).

Direct measures, or performance-based tasks (i.e., highly structured EF tasks conducted during a testing session in an emotionally neutral setting) are considered the "gold standard" of EF skill assessment (Zelazo et al., 2016). The MEFS was administered one-on-one using an iPad by myself. Internet access was necessary to use the MEFS app and to upload student data. I was certified in MEFS administration by Reflection Sciences. Activities completed for certification included completing an online training, submitting a practice video administering the assessment, and passing an assessment. The administration of the MEFS takes approximately four to five minutes per child.

Academic Measures. The Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) assessment is a nationally norm-referenced, computer-based assessment which students take as a part of the school's assessment battery. The MAP math and reading achievement data collected in August at the beginning of the year (BOY) and the end-of-year (EOY) provided measures of academic achievement (See Table 1). The NWEA MAP assessments are adaptive, online assessments which usually have 40 to 50 questions per subject area. Marginal reliability estimates for the NWEA MAP for Primary Grades in reading and math have been reported for kindergarten students as .0.949 and 0.918 respectively (NWEA, 2011). NWEA cites concurrent validity estimates greater than .80 (as cited in Klingbeil, D. A., McComas, J. J., Burns, M. K., & Helman, L., 2015).

Analysis

As was stated in Study 1, to maintain the integrity of random assignment, the analysis was conducted using an intent to treat (ITT) framework, thus all students in the control group from Study 1 were analyzed based on their original assignment to condition rather than a condition that they were later switched to (WWC, 2020). To answer the two research questions multiple regression was used and a dummy variable was included in the regression models for the intervention condition (Mindfulness + SEL) with the control group as the reference group. Effect sizes were calculated using Hedge's *G* for within group effects. An effect size comparing the intervention group to the control condition was also calculated by taking the mean pre-posttest change in the treatment group and subtracting the mean pre-posttest change in the control group and dividing by the pooled pretest standard deviation (Morris, 2008).

Results

Assumption Checking

In order to determine if the data could be appropriately analyzed using multiple regression, the assumptions underlying this technique were checked: linearity, independence, homoscedasticity, normality. The assumption of linearity was met by visually inspecting scatter plots of post-test EF against pre-test EF as well as against student age measured in months. There was independence of residuals, as assessed by a Durbin-Watson statistics which was close to 2 on all regressions (2.307 for Time 2 EF, 1.80 for end of year EF, 2.33 for Math, and 2.13 for Reading). Diagnostics were conducted to determine if any cases had standardized residuals greater than ±3 for regressions of EF, one case was identified which had a standardized residual of 3.215 on the regression exploring post-test EF. On the regression examining end of year reading, three cases were identified which had standardized residuals greater than 3. Visual inspection of a plot of standardized residuals versus standardized predicted values were relatively even in spread and did not reveal any funneling, indicating that the assumption of homoscedasticity was met. Residuals were normally distributed as assessed by visual inspection of a normal probability plot.

Baseline Equivalence

The demographics table (Table 4.5) shows that the average age of students and the gender balance was similar across both conditions. To determine if comparisons could be made between the historical control group and the intervention students, intraclass correlation coefficients (ICCs) were calculated as well as subsequent DEFT values. DEFT values are the square root of the unconditional design effect (McNeish & Stapleton, 2016). ICCs can range from 0 to 1 and values closer to 0 indicate low variability between the means of the different groups. The ICC for historical control and the intervention students for pre-test EF skills (as measured by the MEFS) was 0.018. The ICC on beginning of year (BOY) Math achievement (as measured by the NWEA MAP) was -0.0007 (a negative number indicates a low level of between group variability), and the ICC for BOY Reading Achievement (as measured by the NWEA MAP) was 0.0097. The ICCs were used to calculate DEFT values which were each less than 2. These values indicate low variability between the historical control group and intervention group on initial EF and academic achievement measures and provide support for comparing the groups in the subsequent analysis, as it appears that year to year the kindergarten students performed similarly at pre-test on these measures.

Table 4.5
Demographic Information and Descriptive Statistics, Mean (Standard Deviation)

	Control	n	Mindfulness + SEL	n	All	N
Gender (Male)	22	44	49	97	71	141
Age (Months)-Pre-test	65.43 (4.37)	44	66.05 (3.41)	97	65.86 (3.73)	141
MEFS - EF Pre-test (T1)	47.64 (10.0)	44	42.66 (14.22)	95	44.24 (13.20)	139
MEFS - EF Post-test (T2)	50.14 (15.2)	42	50.62 (13.99)	95	50.47 (14.32)	137
MEFS - EF (T3)	56.94 (19.0)	32	53.83 (15.60)	89	54.65 (16.55)	121
NWEA MAP-Math (T1)	133.23 (9.3)	43	135.05 (10.48)	92	134.47 (10.12)	135
NWEA MAP-Math (T3)	164 (15.0)	40	162.88 (13.74)	94	163.22 (14.10)	134
NWEA MAP-Reading (T1)	138.3 (12.2)	43	134.82 (9.36)	93	135.92 (10.43)	134
NWEA MAP-Reading (T3)	159.45 (13.9)	40	160.18 (12.36)	94	159.96 (12.78)	134

Note. T1= Time 1, beginning of year; T2= Time 2, post-test; T3 = Time 3, end of year

Adjustments for Clustering

The historical control group students were clustered in four classrooms and the students in the intervention condition the following year were also clustered in four classrooms. Thus the present study has eight classroom clusters across the two years/conditions which can be considered a relatively small number of clusters (e.g., McNeish & Stapleton, 2016). However, the standard error estimates are likely to be too small if the clustering is not accounted for, thus it was proposed that the standard error estimates of regression coefficients be multiplied by the DEFT, which is the square root of the unconditional design effect (McNeish & Stapleton, 2016). The DEFT value measures the degree to which the standard error of the mean is inflated due to the clustered nature of the data compared to data from a simple random sample, "a DEFT of 2 means that the standard error will be twice as large in a model that accounts for cluster than in a comparable model that ignores cluster" (McNeish & Stapleton, 2016). The ICCs for classrooms on pre-test (T1) EF skills were 0.0124. The ICC for classrooms on beginning of year (T1) Math achievement was 0.0084, and the ICC for classrooms T1 Reading Achievement was 0.073. These values, which are close to zero, indicate relatively low variability between classrooms on mean initial EF skills and academic achievement scores, however in the subsequent analysis pre-test ICCs were used to calculate DEFT values to adjust the standard errors of the regression models involving EF skills. The classroom level DEFT value for pre-test EF was 1.09, and the BOY reading DEFT was 1.48. These DEFT values were used to adjust the standard errors in the subsequent regression analysis for EF and reading, math was not adjusted due to the very low DEFT value calculated which was less than one (DEFT= 0.37).

Research Question #1 Results

To answer the first research question: "Is there a significant difference between groups (Mindfulness + SEL intervention and control) on EF skills over time (T1 to T2) and (T1 to T3)?" multiple regression analyses were used to regress post-test (T2) EF on pre-test (T1) EF, student age, and intervention condition. A dummy variable ("DV.MindfulSEL") was included in each regression model for the intervention condition (Mindfulness + SEL) with the control group as the reference group. A second regression was used which regressed end of year (T3) EF on pre-test (T1) EF, student age, and intervention condition. In the models examining EF skills, child age was including in the model as age explained some of the variance which was not explained by condition or pre-test score. The regression equations can be expressed in the following form:

$$T2.EF_i = \beta_0 + \beta_1 T1.EF + \beta_2 ChildAge + \beta_3 DV.MindfulSEL + e_i.$$

$$T3.EF_i = \beta_0 + \beta_1 T1.EF + \beta_2 ChildAge + \beta_3 DV.MindfulSEL + e_i.$$

The post-test EF model predicted a statistically significant amount of variance on EF skills at T2, $F(3, 131) = 29.782$, $p < 0.005$, with an adjusted R squared value of 0.39. This can be interpreted as the model explained 39% of the variance in T2 EF skills. When analyzing the main effects, the β weight for the intervention condition was 3.726 ($p = 0.111$). The β weight for T1 EF skills was 0.69 ($p <.001$), thus T1 EF skills significantly predicted T2 EF skills. As described previously, the standard errors and p-values were adjusted on this regression equation using the DEFT value to account for the classroom clustering. The results of the regression are reported in Table 4.6.

Table 4.6
Regression: Post-test (T2) EF

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	-3.77	17.26	-37.92	30.38	0.827		
EF, Pre-test (T1)	0.69	0.07	0.54	0.84	<.001	0.16	<.001
Age (Months)	0.32	0.26	-0.19	0.83	0.218	0.38	0.262
Mindfulness + SEL	3.73	2.11	-0.46	7.91	0.080	4.07	0.111

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using classroom level pre-test EF, DEFT = 1.097

The T3 EF model predicted a statistically significant amount of variance on T3 EF skills, $F(3, 116) = 30.94$, $p < 0.005$, with an adjusted R squared value of 0.43. This can be interpreted as the model explained 43% of the variance in end of year (T3) EF scores. When analyzing the main effects, the β weight for the intervention condition was nonsignificant, β= 1.00 (p = 0.717). The β weight for T1 EF skills was 0.83 (p <.001), thus pre-test (T1) EF skills significantly predicted end of year (T3) EF skills. As described previously, the standard errors and *p*-values were adjusted on this regression equation using the DEFT value to account for the classroom clustering. The results of the regression are reported in Table 4.7.

Table 4.7
Regression: End of Year (T3) EF

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	-4.09	20.51	-44.71	36.53	0.842		
EF, Pre-test (T1)	0.83	0.09	0.66	1.01	<.001	0.10	<.001
Age (Months)	0.32	0.31	-0.29	0.93	0.298	0.34	0.343
Mindfulness + SEL	1.00	2.51	-3.97	5.98	0.691	2.76	0.717

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using classroom level pre-test EF, DEFT = 1.097

Research Question #2 Results

To answer the second research question, “Is there a significant difference between groups (Mindfulness + SEL intervention and control) on academic achievement (math and reading) over time, at end of year testing (T1 to T3)?" multiple regression was used to regress end of year (T3) measures on beginning of year (T1) academic achievement scores (math and reading) and intervention condition. A dummy variable ("DV.MindfulSEL") was included in each regression model for the intervention condition (Mindfulness + SEL) with the control group as the reference group. The regression equations can be expressed in the following form:

$$T3.Math_i = \beta_0 + \beta_1 T1.Math + \beta_3 DV.MindfulSEL + e_i.$$

$$T3.Reading = \beta_0 + \beta_1 T1.Reading + \beta_3 DV.MindfulSEL + e_i.$$

The end of year (T3) math model predicted a statistically significant amount of variance on end T3 math scores, $F(2, 126) = 37.22$, $p < 0.005$, with an adjusted R squared value of 0.36. This can be interpreted as the model explained 36% of the variance in end of year Math scores. When analyzing the main effects, the β weight for the intervention condition was -2.66 (p = 0.218). The β weight for beginning of year (T1) math scores was 0.85 (p <.001), thus T1 math scores significantly predicted T3 math performance. As described previously the DEFT for T1 math was very low (0.37) therefore no adjustments were made to the standard errors. The results of the regression are reported in Table 4.8.

Table 4.8

Regression: End of Year (T3) Math

Effect	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Fixed Effects					
Intercept	50.67	13.27	24.40	76.94	<.001
T1 Math	0.85	0.10	0.66	1.05	<.001
Mindfulness + SEL	-2.66	2.15	-6.91	1.59	0.218

Note. T1= Time 1; CI= confidence interval; LL= lower limit; UL= upper limit

End of year (T3) reading was regressed on T1 Reading, and intervention condition, the three cases which had standardized residuals greater than 3 were removed from the analysis. The T3 reading model predicted a statistically significant amount of variance on end of year reading scores, $F(2, 123) = 26.21$, $p < 0.005$, with an adjusted R squared value of 0.29. This can be interpreted as the model explained 29% of the variance in end of year (T3) reading scores. When analyzing the main effects, the weight for the intervention condition was significant ($p < .05$), $\beta = 4.55$ ($p = 0.021$) but after adjusting the standard errors using the DEFT value, the *p* value increased ($p = .117$) The β weight for T1 reading scores was 0.62 ($p < .001$), thus T1 reading scores significantly predicted end of year (T3) reading performance. As described previously, the standard errors and *p*-values were adjusted on this regression equation using the DEFT value to account for the classroom clustering. The results of the regression are reported in Table 4.9.

Table 4.9

Regression: End of Year (T3) Reading

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	72.30	12.04	48.45	96.14	<.001		
T1 Reading	0.62	0.09	0.45	0.79	<.001	0.13	<.001
Mindfulness + SEL	4.55	1.95	0.69	8.41	0.021	2.88	0.117

Note. T1 = Time 1; CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using classroom level T1 Reading DEFT = 1.48

Effect Sizes

The primary outcome of interest in this study was intervention post-test (T2) EF scores. Effect sizes were calculated two ways: within groups effect size comparing pre and post-test EF scores (see Table 4.10) and group comparison effect sizes. The within group effect sizes for the Mindfulness + SEL condition, comparing Time 2 and Time 1 mean scores can be considered in the medium effect size range (*g* = .64; small = .20, medium = .50, large .80; Cohen, 1992), compared to a very small effect for the control group. An effect size comparing each intervention group to the control condition was also calculated by taking the mean pre-posttest change in the treatment group and subtracting the mean pre-posttest change in the control group and dividing by the pooled pretest standard deviation (Morris, 2008). The group comparison effect size comparing the Mindfulness + SEL intervention to control group was 0.50, 95% CI [0.14, 0.87], also meeting criteria to be considered a medium effect size (Cohen, 1992).

Table 4.10

Within Group Effect Sizes, Pre to Post-test EF

Group	Time 1, EF			Time 2,EF			Hedges G	95% CI	
	n	M	SD	n	M	SD		*LL*	*UL*
Control	44	47.74	10.26	42	50.14	15.2	0.169	-0.067	0.405
Mindfulness + SEL	93	43.03	14.07	93	50.95	13.85	0.644	0.42	0.865

Note. G= Hedge's g for within-group pre-post effect sizes; M= mean, SD= standard deviation, n= number; CI= confidence interval; LL= lower limit; UL= upper limit

Exploratory Analysis with High EF Cases Removed

Prior research has indicated that children with the lowest EF skills prior to intervention are most likely to benefit and demonstrate improvements in EF skills from interventions (e.g., Flook et al., 2010). Given this precedent and the small sample size of the present study, examination of the descriptive statistics of the sample was conducted to determine if there were any cases that were two standard deviations above the mean on pre-test (T1) EF skills. When examining high and low cases from the data set, 7 “high” cases of T1 EF which were greater than two standard deviations from the mean were identified and removed, while the low EF cases remained in the data set, as it was possible these would be the very students that would benefit most from the interventions. A secondary analysis was run to determine if these seven high EF cases being removed would significantly change the findings. The cases were three control group students (from the historical control group, Study 1) and four students from the intervention condition.

The Time 2 EF regression model with seven high EF cases removed, predicted a statistically significant amount of variance on T2 EF, $F(3, 125) = 23.973$, $p < 0.005$, with an adjusted R squared value of 0.35. This indicates the model explained 35% of the variance in posttest (T2) EF scores. When analyzing the main effects, the β weight for the Mindfulness + SEL condition was statistically significant at the $p < .05$ level (β= 5.34, $p = 0.022$). As described previously, the standard errors and p-values were adjusted on these regression equations using the DEFT values to account for intervention group clustering. The results of the regression are reported in Table 4.11.

Table 4.11
Regression: Post-test EF (T2), High EF Cases Removed

Effect	Estimate	*SE*	95% CI		*p*	Adjusted SE	*p*
			LL	*UL*			
Fixed Effects							
Intercept	-1.47	16.76	-34.65	31.71	0.930		
EF, Pre-test (T1)	0.68	0.08	0.51	0.84	<.001	0.09	<.001
Age (Months)	0.28	0.25	-0.23	0.78	0.277	0.28	0.321

Mindfulness + SEL	5.34	2.09	1.20	9.49	0.012	2.30	0.022*

Note. CI= confidence interval; LL= lower limit; UL= upper limit; adjusted SE using classroom level; pre-test EF, DEFT = 1.097; * = $p < .05$

Missing Data and Attrition

Missing data was handled using pairwise deletion. At post-test, the overall attrition rate for EF data collection was 3% overall, with differential attrition at approximately 3% between conditions. At end of year (T3) testing, the overall attrition rate for EF data was 14%, with differential attrition between control and Mindfulness + SEL conditions reaching 19%. According to the WWC standards, at post-test the attrition is tolerable, but at end of year testing the differential attrition may indicate the study had been compromised. At the end of Study 1(Year 1) it was known that at least five students in the study had been unenrolled from the school and its possible enrollment or truancy might explain the missing data at the end of year.

Post-hoc Power Analysis

A post-hoc power analysis was conducted using G*Power (Faul et al., 2007). The estimated power when conducting a linear multiple regression with the present sample size of 137 (the number of complete cases included in the model at EF post-test) and 3 predictors, for a small effect size (f^2=.02) was equal to 0.24, which indicated a 76% chance that a type II error could occur in which a small effect size was present but was not detected. For a medium effect size (f^2= .15) power was equal to 0.97, indicating increased power and a high likelihood that a medium or large effect size would be detectable with the present sample size. Thus the present study was likely underpowered to detect a small effect, but had sufficient power to detect a medium to large effect if it was present. The results of the G*Power post-hoc analysis should be interpreted with caution as this program does not account for the clustering of students and assumes the data is from a simple random sample.

Discussion

Insights from Piloting a New Intervention

In the present study, the effects of a novel Mindfulness + SEL intervention, compared to a historical cohort control group, with classrooms of kindergarten students in an urban setting were examined. Two main research questions guided this study: “Is there a significant difference between groups (Mindfulness + SEL intervention and control) on EF skills over time (T1 to T2) and (T1 to T3)?” and “Is there a significant difference between groups (Mindfulness + SEL intervention and control) on academic achievement (math and reading) over time, at end of year testing (T1 to T3)?”

When looking at the regression model results, the answer to research question one is “no” as there was not a statistically significant beta value for intervention condition in the post-test (T2) EF model nor in the follow-up, (T3) EF model. However, a secondary analysis was conducted which removed seven “high EF” cases and after the removal of these cases, the intervention condition beta was significant in the regression model ($p<.05$, see Table 4.11). This outcome may highlight the differential effectiveness of EF interventions on students with low EF’s benefitting the most from EF interventions (e.g., Diamond, 2014; Flook et al., 2010). Collecting follow-up data on EF skills was a cited limitation of previous research reviewed in the synthesis, and the present study sought to collect follow-up data, however the data on end of year (T3) EF may be compromised by attrition and should be reviewed with caution, additionally the findings were non-significant in the present study on end of year (T3) EF (see

Table 4.7). Although the outcomes of most of the omnibus tests performed were non-significant, inspection of the effect sizes may show support for a pattern of EF skill improvement which favors the Mindfulness + SEL intervention condition (see Table 4.10). Both the within-group and between-group effect sizes favor the intervention condition and can be considered “medium in size” (Cohen, 1992). As stated, the present study was under-powered to likely detect a significant and small effect size (less than .50), which may also explain the seemingly discrepant effect sizes and the generally insignificant findings using regression analyses. This complexity of interpreting findings has also been present in EF intervention studies presented in Chapter 2, as several studies reported effect sizes but also stated they were possibly underpowered (e.g., Flook et al., 2015, Wood et al., 2018).

The answer to research question two, is more direct, in the present study there were no significant differences found between intervention condition and the control group on end of year (T3) reading or math achievement. In fact, a negative relation emerged in the math regression with a negative, but non-significant, beta value being present for the intervention condition students (see Table 4.8). This could possibly be explained by a difference in quality of math instruction over the course of the school year as the students in Study 2 had a new math teacher compared to the Study 1 control group students. Teacher quality may be an important variable to measure and include in future analysis of EF interventions as a lack of subject-matter expertise in instruction cannot be compensated for through EF interventions (or any other “non-academic” intervention).

Importantly, the fidelity analysis included in the present study was robust compared to prior studies discussed in the synthesis (Chapter 2). The Mindfulness + SEL intervention was implemented with 100% fidelity and this may be due to the format of the intervention content which was presented to the class over slides. It is hypothesized that the prescriptive and detailed organization of the sessions within a digital slide deck allowed the interventionist to remain mobile (e.g., circulating the classroom and attending to student needs) while remaining on pace as it was possible to advance to the next slide and follow the script on the slides relatively easily. It was impossible to lose the script or materials or miss a component as advancing to the next slide signaled which portion of the lesson should be implemented next, even if a distraction in the classroom were to occur. The preparation of materials via slides may be a useful technique to carry forward into future interventions.

Limitations

There were at least three limitations to the present study. First, the present study did not use random assignment to determine which students received the intervention and which students were in the control group, this can increase a threat to internal validity. The control cohort attended the school during the prior school year, and it is possible that factors (beyond the EF skills and academic achievement data which were analyzed to establish baseline equivalence) would explain a difference in outcomes. The second limitation is my presence as the sole interventionist in this study and the prior study, thus acting as a confounding factor (WWC, 2020). Finally, as stated in the Results section, the post-hoc power analysis indicated that the present study was somewhat underpowered to detect effect sizes in the small to medium range (less than .50; Cohen, 1992).

Potential Contributions

Despite the limitations, the proposed study and analysis contributes to the literature in three significant ways. First, this study contributes by examining the effects of a short-term, whole class intervention and provides in-depth information about both the dosage of intervention and fidelity to the intervention curricula; previous studies have examined a curriculum (e.g., PATHS, Second Step, MindUP) as it is implemented over the course of a school year but have collected little or no fidelity data. Implementing a year-long curriculum can require a large investment of time and resources from teachers and schools, but if it is possible that a short-term intervention can promote improvement in student EF skills, schools may find it more feasible to include EF interventions as prevention programming in their general education classrooms. Second, this study tests a novel curriculum in a classroom setting. The entirety (year-long sequence) of the Second Step Kindergarten edition and the entirety of the MindUP programs have some overlapping themes such as empathy and perspective taking, however in the present study, a balance of direct social skill practice and self and environmental awareness training via mindfulness was included and achieved in 11 sessions. The Mindfulness + SEL intervention in the present study provides a theoretical explanation and practical example of how to leverage the strengths of each intervention approach (SEL and mindfulness) while keeping in mind the hypothesized weakness of relying too much or solely on one intervention approach to improving EF skills (see Table 4.1). Finally, as stated, EF interventions have been posited as a possible auxiliary avenue to supporting students who are vulnerable to underperformance and may have initially low EF skills due to poverty or other risk-factors in early childhood (e.g., Diamond, 2011). There is encouraging evidence that EF skills are malleable and that interventions which target EF skills have the potential to improve short-term and long-term life trajectories of students (Flook et al., 2010; Takacs & Kassai, 2019). The present study occurred in a public school in a typically under-resourced community, thus the findings of the present study will likely be relevant to schools with similar demographic profiles and may inform best practices for whole-class prevention programming.

Future Directions

The findings from the present study should be interpreted with caution, as the regression model betas for intervention condition were non-significant (except when high EF cases were removed). The effect sizes calculated were in the medium range and this pattern could point to a future line of research exploring whether adjustments to the intervention and if a larger sample size could lead to a larger effect on EF skills. At the practitioner level, the Mindfulness + SEL intervention was relatively low cost, and required a short amount of time to teach whole-group. The sessions averaged 14 minutes and student engagement was generally positive. Students were taught explicit social skills and “learning” behaviors which support classroom success, as well as more reflective and internal awareness processes via mindfulness as they learned to assess their state of being as “mindful” or “unmindful” (see Table 4.3). Given that the intervention was conducted one to two times per week for 6 weeks and medium sized effects were found on post-test EF skills, it is possible that a study which continues the weekly lessons in the spring semester might see continued and increased effects at end of year testing, (effects which were not evident in Study 1 or the present study).

As was mentioned earlier, there is a potential need to incorporate measures of teacher quality beyond student achievement scores, as it is unlikely an EF intervention can compensate in the event of poor instruction in the content areas. Empirical evidence has indicated that teacher pedagogical content knowledge has a positive effect on student academic gains in subject areas such as math (e.g., Baumert et al., 2010). I hypothesize that improved EF skills alone do not lead to improvements on academic skills, but improved EF skills can act as an auxiliary to students as they learn in content areas such as reading and math from qualified instructors. Unless an effective teacher is also present, EF skills will have no impact on academic achievement at any time point. While prior research has indicated that SEL programs also lead to improved academic achievement (e.g., Durlak et al., 2011), it is unclear from reviewing the referenced meta-analysis if teacher quality was taken into account when reporting the improvements in academic achievement alongside SEL interventions. Future researchers should explore the topic of teacher quality further when exploring the effectiveness of "non-academic" interventions on academic measures.

Conclusion

The present study presents the findings from piloting an innovative intervention which combined the strengths of mindfulness-based interventions with the perceived strengths of SEL interventions. The overlapping goals of mindfulness and SEL instruction have been discussed more and more in recent years and theoretical frameworks and empirical studies have been published which explore the possibility of pairing mindfulness and SEL intervention approaches (e.g., Feuerborn & Gueldner, 2019; Lawlor, 2016; Schonert-Reichl et al., 2015). The Mindfulness + SEL intervention in the present study may provide practical guidance on how to bring these two approaches together in a way that is balanced between the approaches ("50:50") rather than embedding some SEL priorities within a mindfulness framework or some mindfulness activities within an SEL program ("70:30"). I hypothesize that the strengths of each approach (mindfulness and SEL) are best leveraged by keeping an equal balance (see Table 4.1). These initial findings may provoke continued investigation and comparison of approaches which can improve the EF skills of young children.

Chapter 5: Conclusion

EF skills are important across the lifespan and are associated with outcomes such as prosocial behavior and school performance (Motamedi et al., 2016; Zorza et al., 2016). Practitioners, policymakers, and researchers have been taking increasing interest in EF skills and the potential for interventions to improve EF skills. The findings from prior research have highlighted that trying to improve EF skills in the early years may be the most crucial and promising time to intervene as these "building blocks" provide students with the tools to manage impulsivity and make choices which facilitate reaching goals (Griffin et al., 2016). Without strong EF skills, students may begin school at a disadvantage and that opportunity gap may only widen with time. Exploring EF skills and subsequent interventions provides a possible avenue to augmenting the instructional practices in schools and enhancing students experience by not only teaching academic skills, but including mindfulness and social skill programs which may support EF skill improvements.

Given the need for strong EF skills (cognitive flexibility, inhibitory control, and working memory) in order to successfully learn and build relationships at school and beyond, I conducted this dissertation to explore the impact of specific intervention approaches on the EF skills of young children. The specific focus on young children (under 7 years old) in the synthesis and in the subsequent intervention studies was important to explore in this dissertation. Empirical evidence has shown that EF development occurs rapidly from age 3 to 6 years old; theoretically it has subsequently been proposed that at this age EF is likely most accurately measured as a unitary construct, as the three domains (cognitive flexibility, inhibitory control, working memory) are working in ways that are so closely overlapping it is hard to distinguish each. As stated at the outset, while a 5 year old and an 8 year old are "close" in age, in the realm of EF skill development and subsequent measurement they may be vastly different, thus it is important to group examination of interventions and approaches by age to possibly glean more fine grain understanding of what is most effective with unique age groups and student populations. Thus the research synthesis (Chapter 2) uniquely explored mindfulness-based interventions conducted with children under seven, highlighting the efficacy of such intervention in promoting EF skills as well as pointing out the complexity of interpreting the findings across studies due to the use of diverse measures. Based on the present synthesis, I conducted Study 1, a randomized control trial of two intervention approaches (mindfulness and SEL) in order to explore the effects of the interventions on EF skills at post-test and at end of year follow-up as well as exploring the effect of the intervention on academic skills in reading and math (Chapter 3). Further building upon the synthesis and Study 1, I conducted an empirical study exploring the efficacy of an innovative intervention (Mindfulness + SEL; Chapter 4). This concluding chapter will offer a final summary of each of the chapters and their contributions to future research.

Research Synthesis

Given the age-specific needs of students and the interest in providing effective interventions, the synthesis provides in-depth descriptions and comparisons of nine mindfulness-based intervention studies which were conducted with students under the age of 7-years old. The synthesis answered two research questions: “What are the characteristics of mindfulness-based interventions which target young children’s executive function skills?” and “What are the effects of mindfulness-based interventions on the executive function skills of young children?” Using the CEC Standards the studies were coded on eight quality indicators: (1) context and setting, (2) participants, (3) intervention agent, (4) description of practice, (5) implementation fidelity, (6) internal validity, (7) outcome measures/dependent variables, and (8) data analysis (Cook et al., 2014).

The coding provided important insight into the methodological trends of the nine mindfulness-based interventions which qualified for inclusion in the synthesis. Eight studies provided an adequate description of the intervention practice and thus a chart was created which provides a helpful practitioner tool to compare and contrast intervention content across studies (see Table 2.3, Appendix A). As assessed using the CEC Standards, implementation fidelity was the quality indicator with the lowest ratings with only three out of nine studies reporting fidelity in terms of adherence to the intervention practice. Four of the studies did not provide evidence of adequate reliability on EF measures, and 6 of the studies did not provide evidence of adequate validity on EF measures. Of the nine included studies, five were eligible to meet the WWC Standards. The synthesis provided insight into the quality of mindfulness-based intervention studies and exposed a need for more empirically sound studies which clarify the effects of EF interventions using measures with strong psychometric properties and which align to the theoretical construct that is most appropriate for this age group of students. The need for measuring and reporting fidelity metrics was also highlighted in the synthesis.

Across all nine studies, 17 distinct measures were used by the authors for the stated purposes of assessing student executive function and self-regulation skills. The synthesis contributes to the literature by thoughtfully categorizing the measures using “The EF Mapping Project Measures Compendium” (Bailey et al., 2018). The compendium groups measures and seeks to provide clarity on which construct a measure is most accurately measuring, whether it be EF skills, delay of gratification, or sub-domains of EF such as measures that purely measure working memory. By grouping the effects by measure and domain, the reader is able to draw conclusions about effects reported and their significance. When examining the effects of intervention on EF skills,, follow-up assessments after the immediate intervention post-testing only occurred in a subset of studies (n= 3, 33%) highlighting another gap in the literature.

The synthesis provoked interest in conducting an intervention study which used a strong, direct measure of EF. Additionally the synthesis revealed a need for fidelity data to be collected in future EF intervention research as well as follow-up data. Subsequently, these were incorporated into the design of Study 1 and Study 2.

Intervention Study 1

In Chapter 3, the difference in relative effects of two different intervention approaches (SEL and mindfulness-based) compared to the control group, during nine weeks of small group intervention with kindergarten students in an urban setting was examined. Two main research questions guided this study: “Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on EF skills over time, immediately following the intervention (T1 to T2)?” and “Is there a significant difference between groups (social-emotional learning, mindfulness-based, and control) on academic achievement (math and reading) and EF skills over time, at end of year testing (T1 to T3)?”

Study 1 sought to directly compare two intervention approaches to determine if one approach was more effective than the other in improving student EF skills at two time points (T2 an T3) and end of year academic achievement. The post-hoc power analysis indicated that the sample size and analysis techniques were likely able to detect a medium to large effect size if this was present, but the study was under-powered to detect a small effect size. The reported regression results consistently indicated that the models which included pre-test scores and intervention condition were significant and were able to explain variance in student outcomes on EF skills and academic achievement, however, the beta values for each intervention condition did not demonstrate significance ($p < .05$) in any of the models. The beta value for the mindfulness-based intervention was closest to significance in the regression model for Time 2 EF when high cases were removed (β=6.73, $p = 0.09$). Effect sizes were also reported in Study 1 and the results were similar in magnitude to those reported in other studies of EF interventions. Takacs & Kassai's (2019) meta-analysis of EF interventions, reported an average effect size of g= .46 for mindfulness practices, and in the present study the mindfulness-based intervention demonstrated an effect size of 0.50 when comparing pre and post-test results and an effect size of 0.47 when compared to the control condition. Takacs & Kassai (2019) reported an average effect size of g=.30 for interventions which are comparable to the SEL intervention used in this study. The SEL intervention in the present study exceeded the effect size reported in the 2019 meta-analysis, as the SEL intervention demonstrated an effect size of g= 0.74 when comparing pre and post-test results and an effect size of 0.50 when compared to the control condition. The results demonstrate a pattern that the intervention students demonstrated differences in EF skills at post-test compared to control group students, but clarity about the degree to which one intervention is more effective than the other is less clear, with a regression model result seeming to slightly favor the mindfulness condition when high EF cases were removed (see Table 3.9) and the effect sizes being somewhat greater for the SEL intervention (see Table 3.8). The under-powered nature of Study 1 may explain why the difference between the two interventions, if small but significant in nature, was not detected in the regression results.

As for the second research question and exploration of the possible impact of EF interventions at follow-up and end of year academic achievement, no beta values were significant, nor did they approach significance at the $p<.05$ level. Takacs & Kassai (2019) reported a small effect at follow-up across intervention studies ($g=0.18$) which was not replicated in the present study, additionally the findings on end of year EF were possibly compromised by the high attrition rate which exceeds guidance from the WWC (2020). The question of whether EF interventions can improve academic achievement continues to be debated with some researchers questioning whether EF interventions can also improve student achievement in subject areas such as math and reading (e.g., Jacob & Parkinson, 2015).

Study 1 contributes to the field of EF intervention research by using a rigorous empirical design (an RCT) and using an EF measure with strong psychometric properties. Additionally, fidelity data was collected and reported, a gap in other studies research (as discussed in Chapter 2). The implementation of both programs informed the intervention designed and implemented in Study 2 and provided practitioner level insights into the intervention content which was most likely to be engaging and effective in improving student EF skills.

Intervention Study 2

In Chapter 4, the effects of a novel Mindfulness + SEL intervention conducted with classrooms of kindergarten students in an urban setting were examined compared to a historical cohort control group (Study 1). Two main research questions guided Study 2: “Is there a significant difference between groups (Mindfulness + SEL intervention and control) on EF skills over time (T1 to T2) and (T1 to T3)?” and “Is there a significant difference between groups (Mindfulness + SEL intervention and control) on academic achievement (math and reading) over time, at end of year testing (T1 to T3)?”

There was not a statistically significant beta value for intervention condition in the post-test EF model nor in the end of year EF model. However, after removing seven "high EF" cases, the intervention condition beta was significant in the regression model ($p<.05$). This outcome may align with the prior research which has indicated the differential effectiveness of EF interventions, as students with low EF skills benefit the most from EF interventions (e.g., Diamond, 2014; Flook et al., 2010). Collecting follow-up data on EF skills was a cited limitation of previous research reviewed in the synthesis (Chapter 2), and Study 2 sought to analyze follow-up data, however the data on end of year (Time 3) EF was likely compromised by attrition, additionally the findings were non-significant in the present study on Time 3 EF (see Table 4.6). Although the outcomes of most of the omnibus tests performed were non-significant, inspection of the effect sizes seemed to demonstrate a pattern of EF skill improvement which favored the Mindfulness + SEL intervention condition over control group students. Both the within-group and between-group effect sizes favor the intervention condition and were considered "medium" in size (Cohen, 1992). Study 2 was under-powered to likely detect a significant and small effect size (less than .50), which may also explain the seeming discrepant effect sizes and the generally insignificant findings using regression analyses. This complexity of interpreting findings was also present in EF intervention studies presented in Chapter 2, as several studies reported effect sizes but also stated they were possibly underpowered and thus had non-significant findings using omnibus tests (e.g., Flook et al., 2015, Wood et al., 2018). Similar to Study 1, in Study 2, there were no significant differences found between intervention condition and control on end of year reading or math achievement.

The fidelity analysis included in Study 2 was robust compared to prior studies discussed in the synthesis (Chapter 2). The Mindfulness + SEL intervention was implemented with 100%

fidelity and this may be due to the format of the intervention content which was presented to the class over slides. It is hypothesized that the organization of the sessions within a digital slide deck allowed the interventionist to remain on pace and maintain a high degree of fidelity to the lesson plan as it was possible to advance to the next slide and follow the script on the slides relatively easily. The preparation of materials via slides may be a useful technique to carry forward into future interventions.

Future Directions

The findings from Study 1 and Study 2 should be interpreted with caution, as the regression model betas for intervention conditions were non-significant (except when high EF cases were removed in Study 2). The effect sizes calculated were in the medium range and provoke interest in exploring if adjustments to the interventions (e.g., dosage, duration, content) and if a larger sample size could produce statistically significant findings and larger effect sizes on EF skills. At the practitioner level, all three interventions: Mindfulness, SEL, and Mindfulness + SEL interventions were relatively low cost, and required a short amount of time to teach. While I have prior teaching experience, I was not extensively trained as a mindfulness instructor but found myself able to internalize and implement the mindfulness-based intervention as well as the Mindfulness + SEL intervention confidently. The sessions for Study 1 were slightly longer (approximately 20 minutes) compared to Study 2's whole group sessions which lasted an average of 14 minutes, in both studies student attitudes were generally positive. Given that the interventions in both studies were conducted one to two times per week for 6 to 9 weeks and medium sized effects were found on post-test EF skills, it is possible that a study which continued the weekly lessons in the spring semester might see continued and increased effects at end of year testing, (effects which were not evident in Study 1 or Study 2).

Study 2 presented the findings from piloting an innovative intervention which combined the strengths of mindfulness-based interventions with the perceived strengths of SEL interventions. The overlapping goals of mindfulness and SEL instruction have been examined through theoretical frameworks as well as in empirical studies (e.g., Feuerborn & Gueldner, 2019; Lawlor, 2016; Schonert-Reichl et al., 2015). The Mindfulness + SEL intervention in Study 2 provided practical guidance on how to bring two intervention approaches together in a way that is balanced between the approaches ("50-50") rather than embedding some SEL priorities within a mindfulness framework or some mindfulness activities within an SEL program ("70-30"). The initial Study 2 findings provoke my own interest in continued investigation and comparison of approaches which can best improve the EF skills of young children.

Conclusion

Both empirical studies reported in this dissertation occurred in a public school in a typically under-resourced community, thus the findings of the present study are likely to be relevant to schools with similar demographic profiles and may inform best practices for students who are at-risk for EF skill deficits. If providing a low cost and relatively easy to implement (with high fidelity) intervention is effective in improving student EF skills, schools would likely be interested in learning about the best approaches. Time is a valuable commodity to all people, but especially in schools and classrooms, as leaders try to make strategic decisions about which programs are best suited for inclusion in the daily schedule. The "cost" of wasted time and instructional efforts is of course highest for the students who are in most need of effective instruction and positive school experiences. How can schools discern between the next trendy educational intervention and an evidence-based practice worthy of the funds and time? As a researcher in training and a practitioner, I have attempted to contribute to the field by tailoring my dissertation to explore a specific age group of students (young children, under 7), by conducting research which was empirically sound, and by attempting to limit the "cost" of time to students and the school by using a sound but easy to implement EF measure and implementing intervention programs at a relatively low to moderate dosage level (1-2 times per week over 6-9 weeks, less than 20 minutes sessions). While the initial findings are not resoundingly significant, I have learned much in the process and am hopeful that the "piece" of the puzzle my dissertation contributes will inform other researchers and practitioners as they make decisions about how to assess and intervene most effectively to support young students' EF skill development, academic achievement, and overall well-being.

Appendix A

Figure 2.1

Synthesis Search Process Diagram

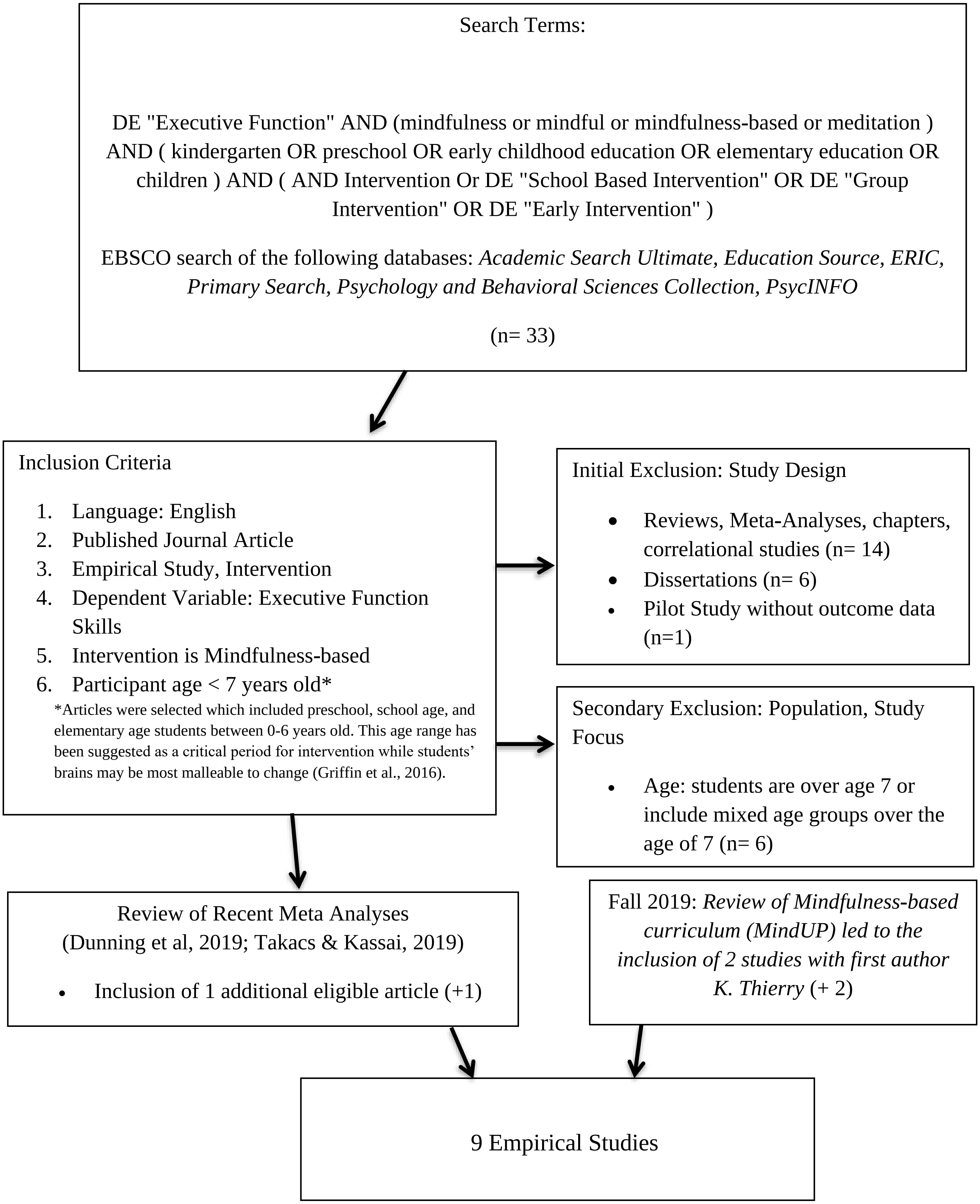


Table 2.1

Study & Participant Characteristics

Study (Year)	**Design**	**Total Sample, Age**	**Subgroups** (n if specified)				**Location**
	-		Proportion of Low SES or Free/reduced meals	Race, Ethnicity	Special Education, Disability status	English Learners	
Emerson, Rowse, and Sills (2017)	Quasi-experimental	N = 26 (6 years old)	“high”	“Mostly white, British” “Small proportion of minority ethnic backgrounds”	“The proportion supported by School Action, School Action Plus, or with a statement of special educational needs was high"	"The proportion that spoke English as an additional language was below average"	England
Flook, Goldberg, Pinger and Davidson (2015)	Randomized control	N = 68 (“preschool” age, *M* = 4.67 years old)	37.9% (of total school population)	58.8% White, 11.8% Hispanic, 11.8% Other/Mixed ethnicity 10.3% Asian/Pacific Islander 5.9% African American	Not specified	Not Specified	Midwestern city, US

García-Bermúdez et al. (2019)	Quasi-experimental	N = 68 (4-5 years old)	1.4% "Low SES" (n=1)	Not Specified	100% "preterm children" "Exclusion criterion was the existence of severe chronic pathology or disability equal to or >33% (mental, sensory, and/or motor")	Not Specified	Spain
Poehlmann-Tynan et al. (2016)	Randomized control	N = 29 (3-5 years old)	100%	72% non-white	Not Specified	Not Specified	Mid-sized Midwestern city, US
Razza, Bergen-Cico, and Raymond (2015)	Quasi-experimental (pretest/posttest treatment and control)	N = 34 (3-5 years old)	Not specified	52% Caucasian, 34% African American, 7% Hispanic, 7% Other	Not specified	Not specified	Urban public schools, Syracuse, NY, US
Thierry, Bryant, Nobles, & Norris (2016)	Quasi-experimental, historical control design	N= 47 (*M*= 4.55 years old)	72% qualified for free or reduced-	85% Hispanic, 9% African American, 6% White	Not specified	51% primary language at home is Spanish	Urban elementary school, large city,

		51% Male, 49% Female	price lunch				Southwestern, US
Thierry, Vincent, Bryant, Kinder, & Wise, (2018)	Quasi-experimental, 4 BAU Schools selected and 4 Intervention condition schools selected	N= 296 (*M*= 4.50 years old) 49% Male, 51% Female	98% free/reduced lunch	57% African American, 40% Latina/o, 1% White, 2% Other	Not specified	First language, Spanish: 27% First language, English: 73%	large city, Southwestern, US
Wood, Roach, Kearney, and Zabek (2018)	Randomized control; no pre-test control v. experimental switching design	N = 27 (3-5 years old)	Not specified	59.3% White, 22.2% Multiracial, 11.1% Black	Not specified	Yes	Southeastern, Urban city, US
Zelazo, Forston, Masten, and Carlson (2018)	Randomized control	N = 218 (*M*= 4.8 years old)	"two schools serving low income families"	School 1, DC (29% reported): 100% African American School 2, Houston (74% reported): 5.4% White, 32.3% more than one, 9.2% African American, 1% Native American “Ethnicity: 97.4% Hispanic”	School 1: 21.4% born premature School 2: 12.6% born premature	School 1: 100% primary language English School 2: 32.3% primary language Spanish	Washington, D.C. and Houston, TX, US

Table 2.2

Intervention Characteristics

Study (Year)	**Intervention Name**	**Intervention Characteristics**					
		Implementer	Setting, Group Size	Duration	Description	Session Outline	Supplementary Materials provided
Emerson, Rowse, and Sills (2017)	Mindfulness-based activities	Trainee clinical psychologist	Classroom, Whole group	4 weeks 2, 30-minute sessions per week 8 sessions	"Mindfulness-based activities based on classical mindfulness practices, which have been adapted for children (Flook et al., 2010; Kaiser-Greenland, 2009; Willard, 2010). The program aimed at cultivating awareness of self, others, and the environment..."	1. "Hello" exercise 2. Focused Mindfulness Activity 3. "Thank you" exercise	No
Flook, Goldberg, Pinger and Davidson (2015)	Kindness Curriculum (KC)	"Experienced mindfulness instructors"	Classroom, Whole group	12 weeks 2, 20-30-minute	"The foundation of the KC is mindfulness practice, aimed at cultivating attention and emotion regulation, with a shared	1. Connection 2. Teaching 3. Active engagement 4. Closing (bell used; "resting into our quiet	Yes, KC sample lessons provided and full scope of 24 lessons

				lessons per week 24 sessions	emphasis on kindness practices	place on the inside")	
García-Bermúdez et al. (2019)	The Stimulating Program in EF for Children (PEFEN)	"Therapist"	Setting not stated, group size unclear	3 months 2 h 30 min session, 1 x per week, total 12 sessions 12 sessions	"This program is based on various neuropsychological models (Diamond & Lee, 2011; Shonkoff , 2010) and on the use of Mindfulness techniques...it is composed of group activities…."	Not specified	No
Poehlmann-Tynan et al. (2016)	Kindness Curriculum (KC)-adapted	Trained instructors; college student mentors present	School, Small group	12 weeks 2, 20-30-minute lessons per week 24 sessions	"The KC is composed of eight themes and includes breathing and movement exercises, music, reading children's literature about kindness and caring, and activities to increase awareness of emotions, sharing, and kind acts (Flook et al. 2015; Kindness Curriculum 2013; Table 1)	1. "Inviting bell" and deep breaths; wishing each person happiness 2. Reminder of previous theme and connect to current session 3. Read a-loud 4. Movement based activity (i.e. animal yoga) 5. Cool-down, restful breathing	Yes, Table 1 includes themes and learning objectives

						(i.e. belly breathing) 6. Final ring of bell	
Razza, Bergen-Cico, and Raymond (2015)	YogaKids- (Wenig, 2003) modified	Teacher, completed 200-h certification training through YogaKids	Classroom, Whole group	25 weeks 10- 30 minutes per day (daily practices, not sessions)	"The mindful yoga program was a modified version of the standardized YogaKids curriculum"	Not session based, but daily activities varied but included: 1. "Breathing and sun salutations during morning circle" 2. "Yoga postures linked to literacy activities in the afternoon" 3. "Breathing activities during transition periods"	No
Thierry, Bryant, Nobles, & Norris (2016)	MindUP	teacher	Classroom, Whole group	School year, and follow-up for a second year 20-30-minute lessons	"15 mindfulness-based lessons, approx. 20-30 min each...three times each day, students engaged in a core mindfulness practice, that of deep breathing with a focus on a single resonant sound"	Not specified	Yes, Appendix of lesson objectives

				15 lessons			
Thierry, Vincent, Bryant, Kinder, & Wise, (2018)	Settle Your Glitter (incorporates aspects of MindUP)	teacher	Classroom, Whole group	School year (October through March) Lesson length not reported 18 lessons	"The mindfulness-based curriculum, known as Settle Your Glitter, consisted of five units ...that incorporated some aspects of MindUP, in particular teaching students about parts of their brain ...each lesson was created in consultation with early childhood education and mental health experts.."	Not specified	Yes, Table 1 with lesson names and objectives
Wood, Roach, Kearney, and Zabek (2018)	Mini-Mind program	Advanced graduate students; lead facilitator was Mini-Mind primary author, had two assistant facilitators	School, Small group	6 weeks 25-minute sessions 12 sessions	"Every session included brief yoga, mindful breathing, and compassion components. In addition, each session used interactive and concrete activities to focus on developing attention and awareness toward one of the following experiences: taste, smell, sight, sound, touch, movement, emotions, and loving-kindness"	Beginning after session 3: 1. Review using learning board 2. Preview using visual schedule 3. Compassion jar 4. Gentle yoga game 5. Breathing buddies and a review of the	Yes, Table 1 with Mini-mind session topics and activities

						learning board	
Zelazo, Forston, Masten, and Carlson (2018)	Mindfulness + Reflection Training	"Local teachers were recruited to deliver two active interventions”	School, Small group	6 weeks 24-minute sessions daily 30 sessions	“Children in the Mindfulness + Reflection group participated in a variety of brief (e.g., 2 min) mindfulness and relaxation practices adapted for children, along with three EF challenging games”	1. Greeting 2. Breathing activity (or other activity) 3. New practices introduced 4. Repetition of previously introduced practices 5. Ending: friendly wishes and a song (“Be Well”)	Yes, Appendix Examples of exercises used in the Mindfulness + Reflection intervention; Lessons 1-14 topics listed

Table 2.3

Intervention Activities and Content

Study (Year)	Intervention	Curriculum Activities and Content						
		Meditation/Stillness/Mindful bodies practice	Parts of the Brain	Breathing	Read Aloud	"Senses"- taste, smell, see, hear, listening, touch; sensory, sounds	Movement; Motor Behavior	Kindness, Compassion, Empathy
Emerson, Rowse, and Sills (2017)	"Mindfulness-based activities"	Yes	No	No	No	Yes	Yes	No
Flook, Goldberg, Pinger and Davidson (2015)	"Kindness Curriculum (KC)"	Yes	No	Yes	Yes	Yes	Yes	Yes
García-Bermúdez et al. (2019)	"The Stimulating Program in EF for Children (PEFEN)"	Yes	No	No	No	Yes	Yes	No

Poehlmann-Tynan et al. (2016)	“Kindness Curriculum (KC)”-adapted	Yes	No	Yes	Yes	Yes	Yes	Yes
Razza, Bergen-Cico, and Raymond (2015)	“YogaKids (Wenig, 2003)” - modified	Yes	No	Yes	No	No	Yes	No
Thierry, Bryant, Nobles, & Norris (2016)	MindUP	Yes	Yes	Yes	No	Yes	Yes	Yes
Thierry, Vincent, Bryant, Kinder, & Wise, (2018)	Settle Your Glitter	Yes	Yes	Yes	No	Yes	Yes	No
Wood, Roach, Kearney, and Zabek (2018)	“Mini-Mind program”	Yes	No	Yes	Yes	Yes	Yes	Yes
Zelazo, Forston, Masten, and Carlson (2018)	“Mindfulness + Reflection”	Yes	No	Yes	Yes	Yes	Yes	No

Table 2.5

EF Measures Across Studies (included in EF Compendium) & Reported Effects

Study (Year)	CEC (Y/N)	N	Measure	D or R	EF Code	Reported Effect(s)
Flook et al. (2015)	Y	68	Delay of gratification (based on Prencipe and Zelazo, 2005)	D	Delay of Gratification	*d*= 0.23
Flook et al. (2015)	Y	68	Dimensional change card sort task (DCCS)	D	Executive Function	*d*= 0.43, *d*= -0.13
Poehlmann-Tynan et al. (2016)	N	29	Head-Toes-Knees-Shoulders Task (HTKS)	D	Executive Function	partial $\eta 2$ = 0.26
Zelazo et al. (2018)	Y	218	Head-Toes-Knees-Shoulders Task (HTKS)	D	Executive Function	
Zelazo et al. (2018)	Y	218	Minnesota executive function scale (MEFS; Carlson and Zelazo, 2014)	D	Executive Function	
Flook et al. (2015)	Y	68	Flanker task	D	Inhibition	*d*= -0.17
Poehlmann-Tynan et al. (2016)	N	29	Go/No-Go Task	D	Inhibition	$\eta 2$ = 0.18, $\eta 2$ = 0.33
Thierry et al. (2018)	Y	296	Flanker task	D	Inhibition	
Razza et al. (2015)	Y	34	Pencil/Peg -Tapping Task (Diamond and Taylor, 1996)	D	Inhibition (also requires Working Memory)	partial $\eta 2$ = 0.19, partial $\eta 2$ = 0.18
Zelazo et al. (2018)	Y	218	Pencil/Peg -Tapping Task (Diamond and Taylor, 1996)	D	Inhibition (also requires	

					Working Memory)	
Razza et al. (2015)	Y	34	Children's Behavior Questionnaire (CBQ; Putnam and Rothbart, 2006)	R	Measure of Temperament	
Zelazo et al. (2018)	Y	218	Children's Behavior Questionnaire (CBQ; Putnam and Rothbart, 2006)	R	Measure of Temperament	
García-Bermúdez et al. (2019)	Y	68	Behavioral Evaluation of Executive Functioning-Children's Version (BRIEF-P)- inhibition, flexibility, emotional control, working memory, planning, coherence	R	Self-Regulation	*d*= 0.39
Razza et al. (2015)	Y	34	Toy Wrap (Murray and Kochanska, 2002) Toy Wait (Murray and Kochanska, 2002)	D	Self-Regulation	partial $\eta 2$ = 0.13
Thierry et al. (2016)	Y	47	Behavioral Evaluation of Executive Functioning-Children's Version (BRIEF-P)- inhibition, flexibility, emotional control, working memory, planning, coherence	R	Self-Regulation	

Note. CEC Standards, Y= Yes, met 80% of quality indicators of CEC Standards, N= No, did not meet 80% of quality indicators; D or R= Direct Measure (D) or Rating Scale (R); EF Codes informed by "The EF Mapping Project Measures Compendium" (Bailey et al., 2018)

Table 2.6

EF Measures Across Studies (Not included in EF Compendium) & Reported Effects

Study (Year)	CEC (Y/N)	N	Measure	D or R	Author Description	Reported Effect(s)
Wood et al. (2018)	Y	27	Teacher Perceived Rating Form (researcher created); Domains: Attention, Working Memory, Inhibition, Shifting (and Social Skills)	R	Measure of progress in EF and social skills	
Emerson et al. (2017)	Y	26	Test of Everyday Attention for Children (TEA-Ch; Manly et al., 2001)- Subtests: Score!, Walk-don't-walk	D	Attentional capacity	d=.70, d=1.06
Emerson et al. (2017)	Y	26	Luria's Hand Game (Hughes, 1996)	D	Inhibition	
Thierry et al. (2018)	Y	296	Hearts and Flowers Task	D	All three components of core executive functioning, including inhibition, working memory, and cognitive flexibility	d= -0.56, d= -0.31
García-Bermúdez et al. (2019)	Y	68	Battery of Computerized Neuropsychological Evaluation of Children (BENCI)-working memory	R	Neuropsychological domains, including but not limited to attention, memory, and EF	d= 1.37
Razza et al. (2015)	Y	34	Drawing Task - Leiter drawing task	D	Sustained attention	

			of sustained attention (Roid and Miller, 1997)			
Wood et al. (2018)	Y	27	Teacher Perceived Rating Form (researcher created); Domains: Attention, Working Memory, Inhibition, Shifting (and Social Skills)	R	Measure of progress in EF and social skills	
Razza et al. (2015)	Y	34	Toy Wrap (Murray and Kochanska, 2002) Toy Wait (Murray and Kochanska, 2002)	D	Self-Regulation	partial $\eta 2 = 0.13$
Thierry et al. (2016)	Y	47	Behavioral Evaluation of Executive Functioning-Children's Version (BRIEF-P)- inhibition, flexibility, emotional control, working memory, planning, coherence	R	Self-Regulation	

Note. CEC Standards, Y= Yes, met 80% of quality indicators of CEC Standards, N= No, did not meet 80% of quality indicators; D or R= Direct Measure (D) or Rating Scale (R); The studies in this table were not included in "The EF Mapping Project Measures Compendium" (Bailey et al., 2018), so the description provided by the study was used in this table.

Appendix B

Figure 3.1

SEL Lesson Plan Template

Social Emotional Learning Intervention Lesson Plan Template (Adapted Second Step Curriculum)

Lesson Component	Script/Language
Listening Rules (1 minute) "Let's review.."	*Uses picture cards from Second Step to review listening rules.*
Quick Review & Warm Up (4-5 min.) "Last time we talked about...what happened (show picture)?" Warm-up Activity	*Reviews picture card and story from the previous week and a brain builder warm-up activity occurs if outlined in the Second Step curriculum. The brain-builder games have been hypothesized to improve EF.*
Today's Objective (1 minute) "Have you ever___..today we will talk about…"	*A preview of the lesson focus is given to focus students' attention.*
Story Time and Discussion (4-5 min.) (see Story Card)	*The story card is a key component of Second Step lessons and provides a picture with scripting of a story and students respond to questions about the scenario depicted on the card.*
Skill Practice (4-5 min.) Direct Practice, or Brain Builder Game/Activity	*Students practice the skill through a game or role-play activity.*
Closing (1 min.) Teacher summarizes learning and suggests application for students	*The lesson is summarized and a connection is made to school about applying the lesson.*

Figure 3.2

Mindfulness-based Lesson Plan Template

Mindfulness-based Intervention Lesson Plan Template (Adapted MindUP Curriculum)

Lesson Component	Script/Language
Quick Review and Warm-up (1-3 min.) "Last time we talked about..."	*This includes the expectations chant a brief review, often this portion reviews the parts of the brain and references a poster which has the parts of the brain labeled.*
"Engage"- Intro/Objective (1-2 minutes) "Today we will talk about.."	*This prepares students to understand the purpose of the lesson and introduces key words.*
"Explore"-Activity or experiment connected to the lesson topic or focus (5-7 minutes)	*This is usually an experiment or activity outlined in the curriculum.*
"Reflect"- debrief the activity through question asking (2 minutes)	*Provides opportunities for students to debrief the activity and make connections to their life at school and at home.*
Mindful Core Practice (3-5 min.) students directly practice mindful meditation	*This activity is repeated each week and students asked if they have practiced a mindful moment on their own since the last time we met.*
Closing (1 min.) Teacher summarizes learning and suggests application for students	*The lesson is briefly summarized and encouraged to apply the lesson to their life.*

Figure 3.3

Sample SEL Lesson: "Lesson 2, Focusing Attention"

Lesson Component	Script/Language
Listening Rules (1 minute) "Let's review.."	Last time we learned the listening rules, let's go over them today and see how well you remember them. (Teacher holds up cards, provides feedback when necessary and students follow along)
Quick Review (1-2 min.) "Last time we talked about...what happened (show picture)?"	(Show card from lesson 1) Last time we learned about the listening rules and how they help Mikayla and her classmates learn and listen to one another. Mikayla uses self-talk and so do the other students to remind themselves to not shout out but to listen (use hand as a "self-talk puppet" to whisper to self, "wait your turn, listen first" and have students repeat)
Today's Objective (1 minute) "Have you ever___..today we will talk about…"	Today we will talk about how and why we focus our attention.
Story Time and Discussion (4-5 min.) (see Story Card)	Follow "Story and Discussion" section on card.
Skill Practice (4-5 min.) Direct Practice, or Brain Builder Game/Activity	We met Puppy last time, but here we have puppy and snail. We are going to play a game now called "Follow, Follow." Make an attent-o-scope and focus your eyes Snail. Now put your attent-o-scope hands down and leave your invisible attent-o-scope on your eyes. So here is the first rule of the game "Do what Snail tells you to do. Puppy will try to trick you by telling you to do things too. IGNORE Puppy." 1. Snail: Follow, follow. Touch your nose. 2. Puppy: Follow, follow. Touch your head. (Don't obey puppy!) 3. Snail: Follow, follow. Touch your ears 4. Snail: Follow, follow. Touch your knees. 5. Puppy: Follow, follow. Touch your head (Don't!) 6. Puppy: Follow, follow. Touch your eyes (Don't) 7. Snail: Follow, follow. Put your hands in the air. 8. Puppy: Follow, follow. Put your hands on your head (Don't!) 9. Snail: Follow, follow. Show a thumbs up! 10. Snail: Follow follow, Pat on your back! Good Job!
Closing (1 min.) Teacher summarizes learning and suggests application for students	Today you learned about focusing your attention by focusing your pretend "Attent-o-scope." Learners need to focus their attention. make your scope and focus on the word. (Point to the word "focus") on the Skills for Learning Poster. You need to use your eyes, ears, and brain to focus attention. Let's name and

	point to the body parts you need to focus attention. Eyes, ears, brains (pointing and repeating). The more you practice, the better you get at focusing attention. Before you do an activity at school you can remind yourself to switch on your attent-o-scope so you can focus your eyes, ears, and brains.

Figure 3.4

Sample Mindfulness Lesson: "Lesson 2, Mindful Awareness"

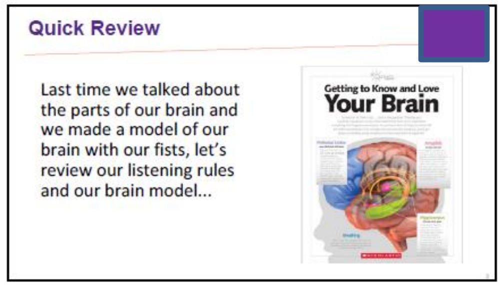
Lesson Component	Script/Language
Quick Review and Warm-up (1-3 min.) "Last time we talked about..."	Last time we talked about the parts of our brain (display and point to poster). We made a model of our brain with our fists (make model with fists). Our prefrontal cortex helps us make decisions, our amygdala is our security guard to keep us safe, and our hippocampus stores our memories. To warm-up today we are going to focus our ears to hear sounds around you with our eyes closed, you may hear noise in the room or the hallway, let's listen very closely. (Optional: ring bell or make quiet sound if there are no sounds to be heard) Share out: What did you hear?
"Engage"- Intro/Objective (1-2 minutes) "Today we will talk about.."	When we listen carefully, we are being mindful. The parts of our brains worked together to help us be mindful. The amygdala sent information about the sound to the PFC to make a decision and then the information about the sounds were stored in our hippocampus. When you listen very carefully you are being mindful. Being mindful means we can think before we act or do something. When we are unmindful we act without thinking. **Today we will compare being mindful (point to brain with both pointer fingers) or unmindful (**thumbs down motion**).**
"Explore"-Activity or experiment connected to the lesson topic or focus (5-7 minutes)	Let's talk about some examples of being mindful or unmindful. Here is an example of being mindful: You taste a food to decide whether you like it. An example of unmindful: You see a food and immediately decide you don't like it. You declare you don't like orange food. This is being unmindful because you did not taste the food, you just looked at it, you could find out you really do like it. -->Read aloud examples from Mindful not Unmindful activity sheet and have students to "mindful" or "unmindful" signal to show their vote
"Reflect"- debrief the activity through question asking (2 minutes)	Let's think about a time you were mindful or unmindful. One time I was unmindful when I blurted out mean words to another person. I was mindful when I stopped the next time and thought about my words before I said them. Have you ever been unmindful or blurted out something? Being mindful takes practice. We need to practice to calm our brains and use our prefrontal cortex (PFC) to make good decisions. Let's turn and kindly remind the person next to you to use your prefrontal cortex.
Mindful Core Practice (3-5 min.)	Last time we practiced being mindful while I shook up the brain jar. I am going to shake up the jar again and we will sit quietly and

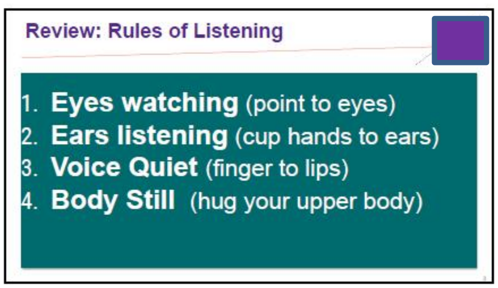
students directly practice mindful meditation	breathe, this time we will try breathing and calming our bodies for 2 minutes. The first minute you can keep your eyes open on the brain jar, and then you can close your eyes. You can also close your eyes the whole time. Calming our bodies helps us to use our prefrontal cortex and be mindful.
Closing (1 min.) Teacher summarizes learning and suggests application for students	Today we learned about being mindful or unmindful (show hand signals) remind yourself and kindly remind others to be mindful in order to make good decisions and to keep your brain and body calm. **Sometimes breathing and taking a mindful moment at school or home is helpful. Try it out and tell us next time if you took a mindful moment on your own.**

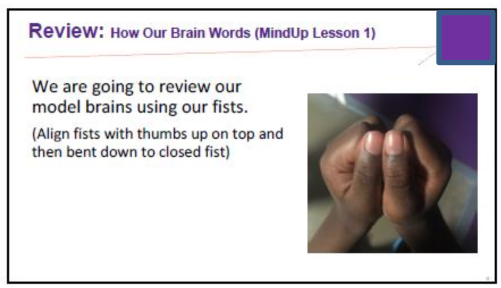
Appendix C

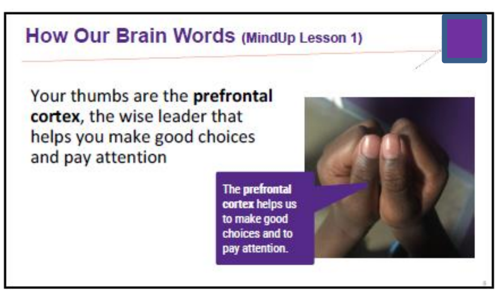
Figure 4.1

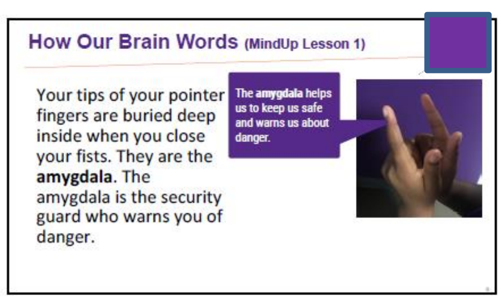
Sample Mindfulness+ SEL Lesson: "Lesson 3, Mindful and Unmindful"

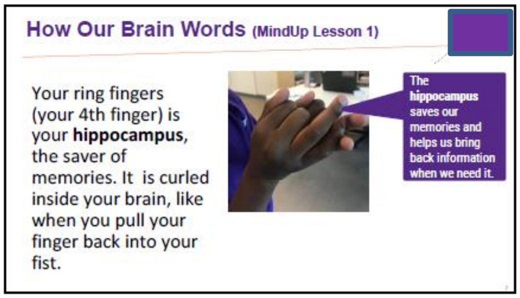


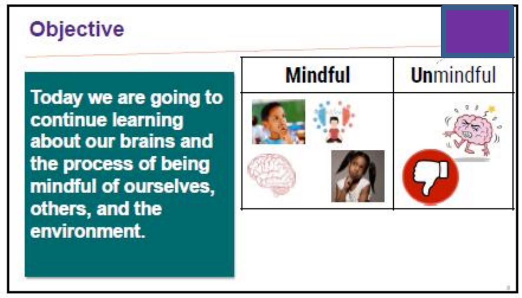


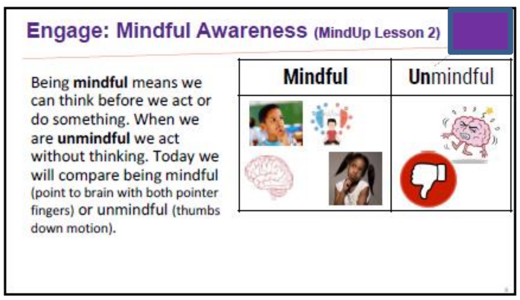


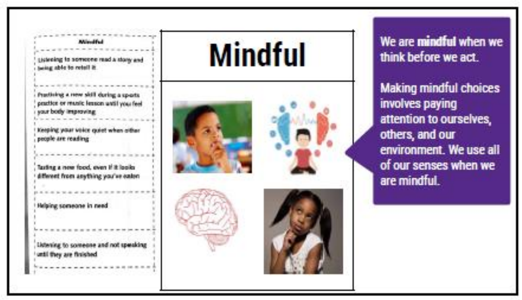


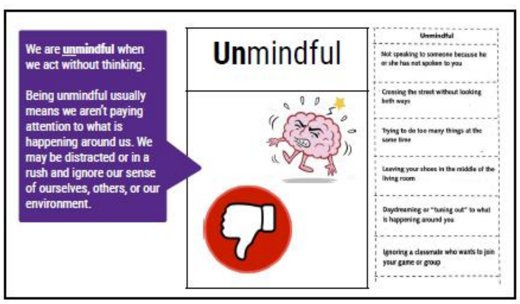


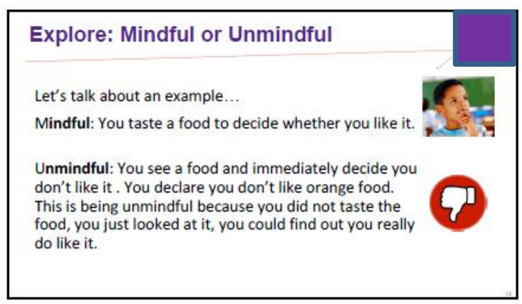

How Our Brain Words (MindUp Lesson 1)
Your ring fingers (your 4th finger) is your **hippocampus**, the saver of memories. It is curled inside your brain, like when you pull your finger back into your fist.
The **hippocampus** saves our memories and helps us bring back information when we need it.

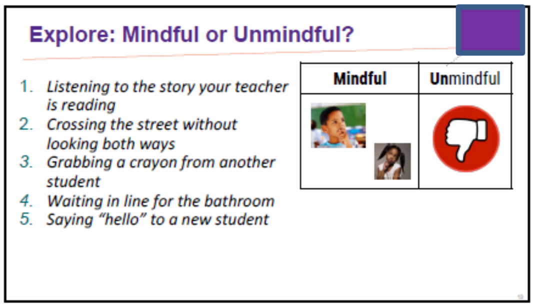

Objective
Today we are going to continue learning about our brains and the process of being mindful of ourselves, others, and the environment.
Mindful
Unmindful

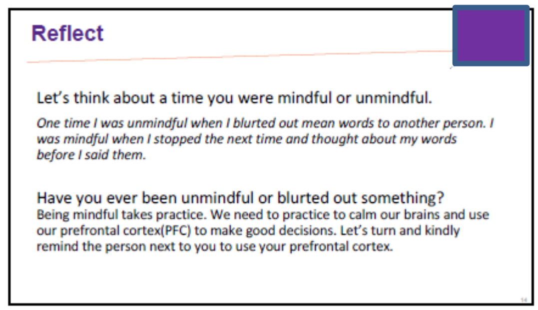

Engage: Mindful Awareness (MindUp Lesson 2)
Being **mindful** means we can think before we act or do something. When we are **unmindful** we act without thinking. Today we will compare being mindful (point to brain with both pointer fingers) or unmindful (thumbs down motion).
Mindful
Unmindful

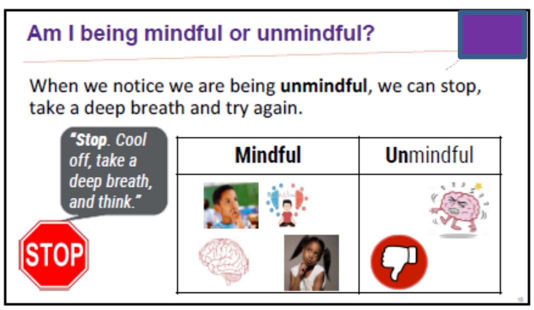

Mindful
Listening to someone read a story and being able to retell it
Practicing a new skill during a sports practice or music lesson until you feel your body improving
Keeping your voice quiet when other people are reading
Tasting a new food, even if it looks different from anything you've eaten
Helping someone in need
Listening to someone and not speaking until they are finished
Mindful
We are **mindful** when we think before we act.
Making mindful choices involves paying attention to ourselves, others, and our environment. We use all of our senses when we are mindful.

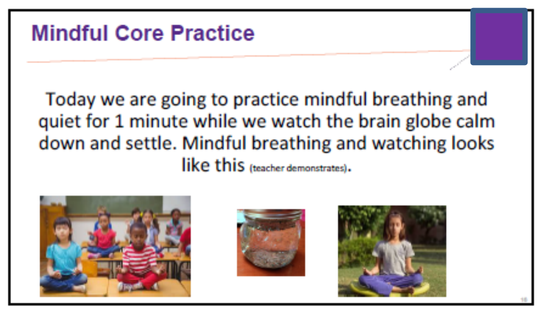

We are unmindful when we act without thinking.
Being unmindful usually means we aren't paying attention to what is happening around us. We may be distracted or in a rush and ignore our sense of ourselves, others, or our environment.
Unmindful
Unmindful
Not speaking to someone because he or she has not spoken to you
Crossing the street without looking both ways
Trying to do too many things at the same time
Leaving your shoes in the middle of the living room
Daydreaming or "tuning out" to what is happening around you
Ignoring a classmate who wants to join your game or group


Explore: Mindful or Unmindful
Let's talk about an example…
Mindful: You taste a food to decide whether you like it.
Unmindful: You see a food and immediately decide you don't like it . You declare you don't like orange food. This is being unmindful because you did not taste the food, you just looked at it, you could find out you really do like it.


Explore: Mindful or Unmindful?
1. Listening to the story your teacher is reading
2. Crossing the street without looking both ways
3. Grabbing a crayon from another student
4. Waiting in line for the bathroom
5. Saying "hello" to a new student
Mindful
Unmindful


Reflect
Let's think about a time you were mindful or unmindful.
One time I was unmindful when I blurted out mean words to another person. I was mindful when I stopped the next time and thought about my words before I said them.
Have you ever been unmindful or blurted out something?
Being mindful takes practice. We need to practice to calm our brains and use our prefrontal cortex(PFC) to make good decisions. Let's turn and kindly remind the person next to you to use your prefrontal cortex.


Am I being mindful or unmindful?
When we notice we are being unmindful, we can stop, take a deep breath and try again.
"Stop. Cool off, take a deep breath, and think."
STOP
Mindful
Unmindful


Mindful Core Practice
Today we are going to practice mindful breathing and quiet for 1 minute while we watch the brain globe calm down and settle. Mindful breathing and watching looks like this (teacher demonstrates).

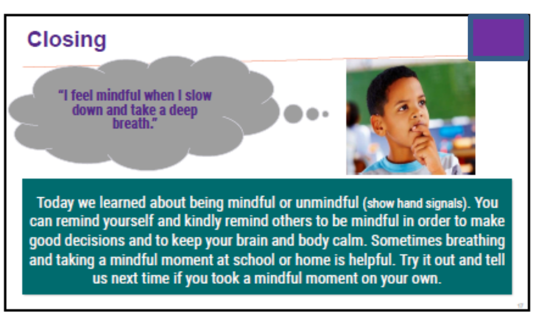
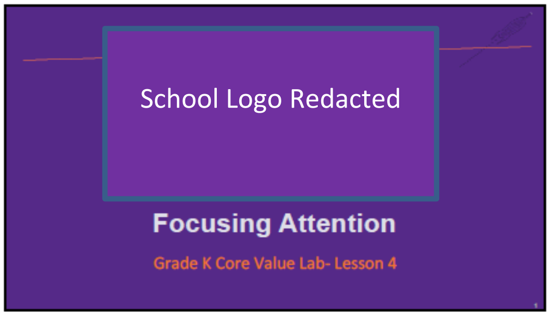
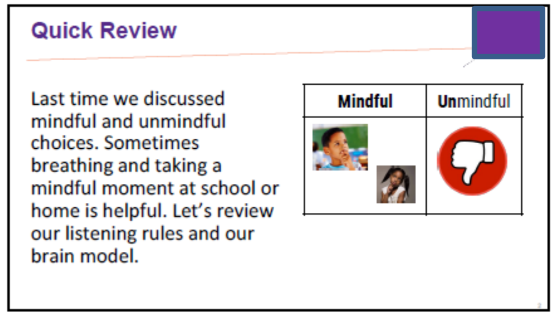
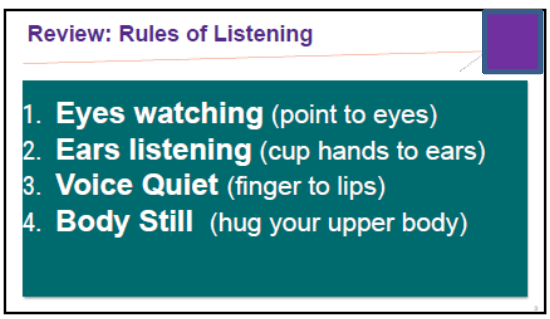

Closing
"I feel mindful when I slow down and take a deep breath."
Today we learned about being mindful or unmindful (show hand signals). You can remind yourself and kindly remind others to be mindful in order to make good decisions and to keep your brain and body calm. Sometimes breathing and taking a mindful moment at school or home is helpful. Try it out and tell us next time if you took a mindful moment on your own.

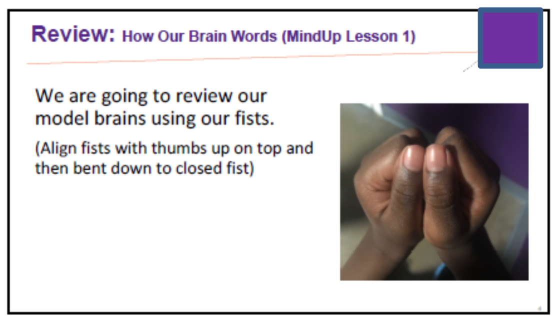
Figure 4.2

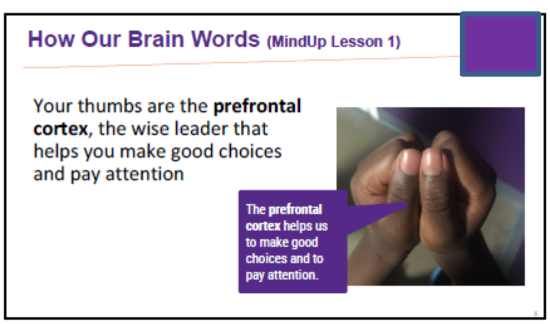
Sample Mindfulness+ SEL Lesson: "Lesson 4, Focusing Attention"

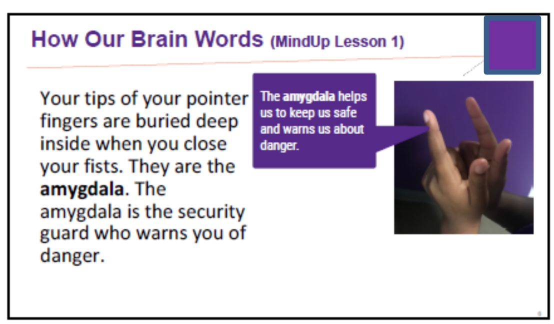












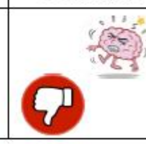
How Our Brain Words (MindUp Lesson 1)

Your ring fingers (your 4th finger) is your **hippocampus**, the saver of memories. It is curled inside your brain, like when you pull your finger back into your fist.

The hippocampus saves our memories and helps us bring back information when we need it.

Review: Am I being mindful or unmindful?

Remember, when we are **mindful** we are focused and paying attention to our brain and body. When we notice we are being **unmindful**, we can stop, take a deep breath and try again.

Mindful	Unmindful
	

Objective

Today we are going to think about how and why we focus our attention.

If you put your hands up to your eyes (like binoculars) you can make an attent-o-scope. An attent-o-scope can help us focus our attention.

Focusing Attention (Second Step GK, L2)

Here is a story about a classroom of students like you…

This is Caleb, he is in his math class. His teacher, Mrs. Williams is explaining a number story to him. Caleb really wants to understand the number story.

The classroom is noisy and he wants to look around, but he reminds himself to focus his attention by looking at his teacher to help him listen carefully.

Focusing Attention (Second Step GK, L2)

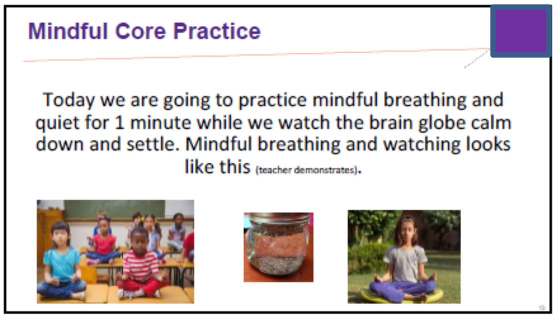
1. What is Caleb doing?
2. Which **rules of listening** do you see Caleb following?
3. How do you think the teacher, Mrs. Williams, feels? (How does it feel when other people listen carefully to you?)

Put your hands around your eyes like binoculars. This is your **attent-o-scope.** It helps you focus your attention like Caleb is doing.

Skill Practice: "Follow, Follow" Game

We are going to play a game now called "Follow, Follow" Make an attent-o-scope and focus your eyes Snail. Now put your attent-o-scope hands down, and leave your invisible attent-o-scope on your eyes. So here is the first rule of the game **"Do what Snail tells you to do. Puppy will try to trick you by telling you to do things too. IGNORE Puppy."**

1. Snail: Follow, follow. Touch your nose.
2. Puppy: Follow, follow. Touch your head. (Don't obey puppy!)
3. Snail: Follow, follow. Touch your ears
4. Snail: Follow, follow. Touch your knees.
5. Puppy: Follow, follow. Touch your head (Don't!)
6. Puppy: Follow, follow. Touch your eyes (Don't)
7. Snail: Follow, follow. Put your hands in the air.
8. Puppy: Follow, follow. Put your hands on your head (Don't!)
9. Snail: Follow, follow. Show a thumbs up!
10. Snail: Follow follow, Pat on your back! Good Job!


Mindful Core Practice
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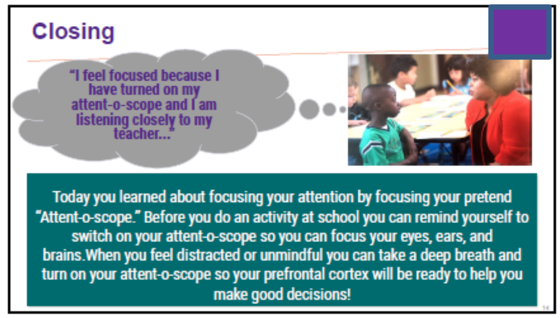
Closing
"I feel focused because I have turned on my attent-o-scope and I am listening closely to my teacher..."
Today you learned about focusing your attention by focusing your pretend "Attent-o-scope." Before you do an activity at school you can remind yourself to switch on your attent-o-scope so you can focus your eyes, ears, and brains.When you feel distracted or unmindful you can take a deep breath and turn on your attent-o-scope so your prefrontal cortex will be ready to help you make good decisions!

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