Journal: Applied Developmental Science

Publication Year: 2024

Mindfulness Training Enhances Students' Executive Functioning and Social Emotional Skills

Lisa Flook[1], Matthew J. Hirshberg[1, 2], Lori Gustafson[1],

Chad McGehee[1], Cara Knoeppel[3], Lawrence Y. Tello[4],

Daniel M. Bolt[2], & Richard J. Davidson[1]

[1]Center for Healthy Minds, University of Wisconsin-Madison

[2]Department of Educational Psychology, University of Wisconsin-Madison

[3]Educational Psychology and Learning Systems, Florida State University

[4]California Department of Public Health

Lisa Flook https://orcid.org/0000-0001-7832-090X
Matthew J. Hirshberg https://orcid.org/0000-0001-9070-1270
Lori Gustafson https://orcid.org/0000-0001-7955-2470
Chad McGehee https://orcid.org/0000-0003-0774-0442
Cara Knoeppel https://orcid.org/0000-0001-7761-624X
Lawrence Tello https://orcid.org/0000-0002-9051-8342
Daniel Bolt https://orcid.org/0000-0001-7593-4439
Richard J. Davidson https://orcid.org/0000-0002-8506-4964

Correspondence concerning this article may be addressed to Lisa Flook.

Email flook@wisc.edu

Abstract

More research is needed to understand the effects of school-based mindfulness programs in the years before adolescence, which represent a critical juncture and transitional period of development. The present study investigated mindfulness with elementary school students using random assignment and objective measures. The sample included 292 5th graders from 21 classrooms randomly assigned to an 8-week mindfulness training or wait-list control group. Students were assessed at pre- and post-intervention on behavioral measures of executive functioning and teacher-rated social emotional competence, along with end of year social-emotional learning report card grades. Analyses using hierarchal linear modeling found that students in the intervention group demonstrated significant gains on a computerized task of cognitive flexibility, and end of year social-emotional learning grades controlling for prior year grades, but not teacher reported social emotional competence. Taken together these findings point to a simple, yet promising method for bolstering students' cognitive and social emotional skills.

Keywords: Mindfulness, Executive function, Intervention, Social emotional skills, Emotional regulation, Prosocial behavior

Mindfulness training enhances students' executive functioning and social emotional skills

In order to promote whole child development, robust approaches are needed to cultivate social emotional competencies alongside cognitive skills. Although research demonstrates that Social Emotional Learning (SEL) curricula boost academic achievement (Durlak et al., 2011), there is still a pervasive perception that social emotional competencies are soft skills that take second place in classroom curricula. And even though executive functions (EF) are recognized as fundamental skills that underlie academic achievement (Blair, 2002), there is relatively little explicit instruction offered in schools for training these cognitive abilities. Promoting children's holistic development requires supporting both their cognitive and social emotional capacities.

Social Emotional Learning

While SEL training takes a variety of shapes and sizes, there is still a prevalent belief that time spent on social emotional skills instruction in the classroom is less important than, or even detracts from, core academic content (Finn & Hess, 2019). Yet focusing solely on academic subjects does not adequately prepare children to navigate the social and emotion terrain of their lives, which becomes increasingly complex as children enter late childhood and early adolescence. Social emotional competence encompasses individual and interpersonal skills including emotion regulation and forming and maintaining positive relationships with others that enable individuals to function effectively in working towards goals and navigating setbacks as well as interacting successfully with others (Domitrovich, Durlak, Staley, & Weissberg, 2017). SEL curricula are gaining widespread recognition for bolstering children's social emotional competence as well as improving academic achievement (Taylor, Oberle, Durlak, & Weissberg, 2017). Despite the social-emotional and academic benefits of SEL training documented by a growing research literature (e.g., Durlak et al., 2011), educators are hard pressed to fit SEL

training into already busy classroom routines. Additional approaches that provide educators with a variety of options for supporting students to develop their full potential are needed.

Executive Functioning

Executive functions (EFs) are core cognitive processes that refer to a broad array of distinct yet related functions, such as working memory, inhibitory control, and cognitive flexibility (Miyake et al., 2000). EFs are involved in self-regulation and collectively impact upon all areas of an individual's functioning including thinking, feeling and behavior (Zelazo, Carlson, & Kesek, 2008). EFs are a fundamental component of school success that predict academic performance above and beyond general levels of intelligence (Blair & Razza, 2007).

The importance of EFs to a host of academic, social, health, and labor market outcomes (Moffit et al., 2011) has led to interest in identifying strategies to promote their development. However, most cognitive skills trainings have proven to be too narrow, failing to transfer or generalize to other non-trained skills or domains (Kassai, Futo, Demetrovics, & Takacs, 2019). For example, while computer-based programs that train specific EFs such as working memory are widely utilized, they have demonstrated limited impacts beyond training effects (Melby-Lervag, Reick, & Hulme, 2016). Scholars have postulated that developmentally appropriate practices during childhood and adolescence that engage core EF processes may promote durable growth in EFs (Diamond & Lee, 2011). The development of prefrontal cortical regions linked to EFs undergo significant development during this period (Diamond, 2002). Moreover, the transition between late childhood and early adolescence marks a particularly critical second window of development (Dahl et al., 2017) linked to brain plasticity (Laube, van den Bos, & Fandakova, 2020). Neural pathways that are reinforced through thought, behavior and action become more strongly linked through a process known as myelination (Corrigan et al., 2021).

Myelin serves to insulate neural pathways and make them more efficient. Pathways that are not reinforced are "pruned" during this critical developmental stage (Sisk & Foster, 2004). By strengthening students' capacities at this foundational stage, they may be better equipped to navigate the challenges and demands of adolescence and onward throughout life (Andersen, 2002).

Mindfulness

Mindfulness involves training attention by maintaining awareness on an object, whether it is the breath, other bodily sensations, external stimuli, thoughts or emotions. Mindfulness practice further entails noticing when the mind has wandered from the object of attention (monitoring) and returning the mind back to the object of attention (shifting/cognitive flexibility) when mind-wandering has been recognized. Finally, training in these processes strengthens the ability to bring attention back and refocus a wandering mind with an attitude of gentle acceptance (Lindsay & Creswell, 2017). Through a variety of specific practice techniques, these basic skills are reinforced through repetition.

Mindfulness practices have increasingly received attention as a potential avenue for promoting whole child development as part of school curricula (Darling-Hammond, Flook, Cook-Harvey, Barron & Osher, 2020). Mindfulness is defined as the awareness that arises from paying attention in a particular way; that is, on purpose, in the moment, and without judgment (Kabat-Zinn, 2013). Applications of mindfulness-based approaches have been explored in a wide variety of settings with an array of documented benefits, most extensively with adult populations (Goldberg, Riordan, Sun, & Davidson, 2022). The most widely researched mindfulness training program is Mindfulness-Based Stress Reduction which was developed over 40 years ago to treat patients with intractable chronic pain and has since been extended to treat a variety of mental and

physical health conditions, and is recognized for enhancing overall well-being (e.g., Grossman et al., 2004; Khoury et al. 2015). Investigations into applications of mindfulness in school settings are at an earlier stage, but initial evidence suggests benefits for both students and teachers (e.g., Roeser et al., 2013; Schonert-Reichl et al., 2015).

Research on mindfulness and similar forms of contemplative training with adults indicates that training increases the ability to sustain engagement of self-regulatory neural circuits resulting in improved sustained attention and emotion regulation (Lutz, Slatger, Dunne, & Davidson, 2008) as well as alterations in functional connectivity of brain networks associated with attentional focus (Kilpatrick et al., 2011). Training attention is considered a precursor to the deliberate cultivation of positive qualities through, for example, specific practices designed to promote empathy (Klimecki, Leiberg, Lamm, & Singer, 2012) and prosocial attitudes (Weng et al., 2013). Particularly relevant for student implementations intending to improve social-emotional learning, mindfulness training has been found to promote prosocial behavior even without explicit instruction in ethical behavior (Berry et al., 2020).

Training of awareness is a salient feature of mindfulness practice and overlaps with the core competencies identified in a widely recognized Social Emotional Learning framework (CASEL, n.d.). Arguably, self-awareness is the foremost skill upon which the other skills of self-management, other awareness, relationship building, and decision making rely. While still a nascent field of research, effect sizes derived from mindfulness interventions are comparable to those observed in SEL studies, ranging from standardized mean differences between intervention and control groups of 0.22 to 0.57 across target domains including social behavior, emotional distress, and academic performance (Waters, Barsky, Ridd & Allen, 2015; for a review of mental health in schools see Carsley, Khoury, & Heath, 2017).

A glance at the state of the field reveals a variety of curricula available for training mindfulness with students. The particular form of training varies across studies and some curricula blend mindfulness with other approaches such as SEL. Mindfulness is a unique approach for a student training, in that the skills are also directly applicable to teachers as a practice for themselves, although fewer trainings are tailored for educators (but see e.g., Hirshberg, Flook, Enright, & Davidson, 2020; Roeser et al., 2013). Most school-based studies have examined outcomes of mindfulness interventions with students in the areas of social-emotional functioning and executive functioning separately; few studies have investigated these outcomes jointly even though they are both established as important components of school success. In addition, measures have largely been self-report with only a handful of studies utilizing EF task performance. Existing studies also vary on whether random assignment was used and assessments beyond post-test are rare leading to questions about treatment effects over time.

Extant research on mindfulness with students shows effects across a range of methods including self-report and behavioral tasks. A meta-analysis of mindfulness training for children implemented in school settings that included 24 studies found moderate overall effects sizes (measured using Hedge's g) with the strongest gains in areas of cognitive performance (g=.80, particularly attention), stress (g=.39), and resilience (g=.36), and smaller effects on reductions in emotional problems (g=.19; Zenner et al., 2014). Most of these effects were based on self-report data. Another meta-analysis of mindfulness that included clinical populations found small to medium effects compared to active control conditions, with the largest effects found for reductions in psychological symptoms (effect size = .37; Zoogman, Goldberg, Hoyt, & Miller, 2015). Results from a comprehensive meta-analysis of 76 studies published through 2015 were

consistent with these earlier conclusions (Klingbeil et al., 2017). However, this more recent meta-analysis (Klingbeil et al., 2017) found that only 16 of the school-based studies reviewed met criteria for the What Works Clearinghouse standard for methodological rigor, which is evaluated based on randomization procedures, low attrition, and baseline equivalence. A majority of those studies focused on adolescents, whereas, only two studies targeted older elementary age students, suggesting the need for more methodologically rigorous research (that involves random assignment and non-self-report based measures) in this developmental period.

In addition to the small number of experimental studies, there is considerable variation in instructional approaches, sample characteristics, outcomes, and measurement methods of mindfulness-based intervention studies. Of studies employing a randomized design, one tested a program blending mindfulness and SEL in a sample of 99 4th and 5th grade children from a predominantly middle-class background (Schonert-Reichl et al., 2015). This study assessed EF through behavioral tasks and social emotional indicators via children's self-report and peer nominations. The mindfulness-based SEL program consisted of 12 lessons lasting 40-50 minutes approximately once per week. Core mindfulness practices included breathing and attentive listening practiced for 3 minutes three times per day. Lessons also targeted EFs and self-regulation, social-emotional understanding, positive mood, and performing acts of kindness. The control group received a standard curriculum in social responsibility. Children in the intervention group showed faster reaction times on computer tasks of attention, inhibitory control, and cognitive flexibility without compromising accuracy. Child self-report measures including empathy, self-concept, and depressive symptoms all showed improvement. Additionally, children in the intervention group were rated as more prosocial by their peers.

A second study with inner city youth involved 97 4th and 5th grade students in yoga training (Mendelson et al., 2010). This study assessed student self-report of stress, psychological symptoms, and social relationships. Two schools were randomized to receive the 12-week intervention delivered for 45 minutes, four days per week, while the other two schools served as a wait-list control. The yoga program involved breathing exercises along with a series of poses designed to strengthen and stretch the body through physical activity. Student self-reports indicate less reactivity to stress, in particular, less rumination, emotional arousal, and fewer intrusive thoughts. No changes were detected in student reports of relationships with their teacher or peers.

Another study with students in this age range documented benefits in a low-income African American sample (*n*=350, 99.7% African American) after a 12-week mindfulness intervention (Sibinga, Webb, Ghazarian, & Ellen, 2016). Note, this study was not included in the meta-analysis referenced above because it was published after the literature review was complete. This study primarily focused on student self-report of psychological symptoms, highly relevant in this at-risk population. The sample of 5th to 8th grade students self-reported on measures of psychological symptoms, coping, affect, and post-traumatic stress before and after the intervention. Data analysis involved comparisons of post-test scores between the mindfulness group and an active health training control condition; no baseline differences were reported. At post-test students in the mindfulness group reported less rumination, somatization, negative affect, negative coping, depressive symptoms, self-hostility, and fewer post-traumatic symptoms.

While the literature is growing, additional research that rigorously investigates the role of mindfulness on student outcomes is needed. Older elementary school children may be at a prime developmental period for intervention as they are on the brink of pre-adolescence before they

transition into middle school when behavioral and psychological problems spike (Merikangas, Nakamura & Kessler, 2009). Likewise, they are in a period of development when there is a high level of neural plasticity. Intervening during late childhood to reinforce healthy habits of mind may harness the natural plasticity occurring during this developmental period to establish a positive trajectory into adolescence and adulthood (Dahl, 2004).

The current study aimed to draw from the most well-researched mindfulness intervention, Mindfulness-Based Stress Reduction, by adapting it for both teachers and students. The current paper focuses on student outcomes and is part of a larger project investigating sustainability of mindfulness in school settings for which teacher training was expected to be a key component. This study incorporated objective and teacher-report measures, consisting of behavioral tasks, teacher reported student outcomes at post-test, and end of year report card grades conferred approximately 2 months after the end of the intervention. By adapting an empirically established mindfulness program that does not blend other approaches, this represents a test of mindfulness itself as the active ingredient.

A primary hypothesis of the study was that mindfulness training would lead to improved EFs, specifically inhibitory control and cognitive flexibility based on prior research with school age children, and working memory was also included as it is a core EF that has been shown to improve with mindfulness training in adults (Jha et al., 2019). A second hypothesis was that students would show gains in social emotional competence indexed by teacher-report at post-test as well as on end of year SEL grades.

Methods

Participants

Students. Participants were 292 public school fifth graders (43.8% female, *n*=128) from four urban (49%, *n*=144) schools in the same district and one neighboring suburban public-school (51%, *n*=148) in the upper Midwest of the United States. About 61% of eligible fifth-graders enrolled in the study. Of the students reporting race, the majority self-reported as White (60%, *n*=168); 45 as African-American (15.4%), 38 students reported as Hispanic (13.0%), 26 as Asian/Pacific Islander (8.9%), and 5 as multi-racial (1.7%). One hundred fifty-four students were in the intervention group (53%) and 138 students in the wait-list control group (47%). The mean age of students was 10.91 years (*SD* = 0.68). Based on publicly available data, our sample composition in terms of gender and race/ethnicity was representative of the students from the participating districts (i.e., 59% White, 11% Black, 15% Hispanic, 8.5% Asian, and 7.5% two or more races; 49% female). See Table 1 for full demographics.

{INSERT Table 1. ABOUT HERE}

Teachers. Teacher participants were 21 fifth grade public school lead classroom teachers. All eligible teachers from participating urban schools (*n*=15) and 90.9% of eligible teachers from the suburban school (*n*=9) consented to participate. They were 70.83% female (*n*=17), 66.67% (*n*=16) self-reported as White/Caucasian, 8.33% (n=2) as Hispanic, 8.33% (n=2) as more than one race, and 4.17% (n=1) as Black/African American. On average, teachers were 41.06 years old (*SD*=9.85) and had been teaching fifth grade for 4.93 years (*SD*=4.36), About 38% (*n*=8) of teachers earned a bachelor's degree with 61.9% (*n*=13) having earned a master's degree.

Materials and Procedures

School and classroom recruitment and random assignment. In the year before this study commenced, district administrators from one urban and one neighboring suburban public school district agreed for participants to be recruited from their schools. Principals from schools in the

urban district serving high proportions of students on free and reduced lunch (i.e., >50%) and the principal of the largest school in the suburban district were contacted to gauge interest in participating in the study.

Five urban school district principals and the suburban school district principal agreed to allow their teachers and students to participate. Prior to the start of the school year and this research, eligible teachers were recruited from these schools to enroll in a study on the impact of teacher and student mindfulness training (Figure 1). Interested and eligible teachers met with research staff, were told about the study procedures and timeline, and what would be requested of them. Teachers were provided with a written, IRB approved consent document that outlined their participation, and after having been provided time to read the consent form, were asked if they had any questions. Following this process, interested teachers signed the consent document and were enrolled in the study. In the beginning of the fall after all consenting teachers had completed pre-testing, we block randomized by school via a random number generator to ensure that roughly half of the classrooms in each school (and therefore district) were assigned to intervention and the other half to the wait-list control. Thirteen classrooms were assigned to intervention (*n*=9 urban, *n*=4 suburban) and 11 to wait-list control (*n*=6 urban, *n*=5 suburban).

Citing time conflicts, all three teachers from one urban school (*n*=2 intervention, *n*=1 control) collectively decided to end participation after pretesting but before intervention onset, resulting in an analysis sample of 21 classrooms (11 intervention, 10 wait-list control). Teachers assigned to the teacher-level mindfulness intervention completed the intervention over the fall/early winter during professional development time. Teachers who participated in the study were eligible to receive a small honorarium and school supplies for their classroom.

After the completion of the teacher intervention, students of participating teachers were recruited into the study (Figure 1). Students were recruited by an in-class visit to participating classrooms and information packets were sent home to students' parents notifying them of the study opportunity. Only students who returned a signed parental consent form were eligible for the assent process. Researchers provided eligible students with written assent forms which were read aloud by members of the research team. Students were provided with time to review the assent and ask questions of the researchers. Students who participated in the study received school supplies. Both parental consent and student assent were required before students were enrolled as research participants. Student condition assignment was based on teacher assignment. To avoid selection bias, researchers did not provide students with information about condition assignment during recruitment and teachers were explicitly asked not to communicate to students any information about their condition assignment. In addition, student pre-test occurred after the completion of the teacher intervention.

In the following school year, teachers in the intervention taught their students the student curriculum; meanwhile teachers from the wait-list control condition participated in the teacher intervention in the Fall and co-taught the student intervention in the Spring, mirroring the procedures reported on here. This design allowed the larger research project from which this randomized controlled trial was drawn to examine sustainability by examining whether teachers who in the prior year had received personal instruction in mindfulness and then helped facilitate a student mindfulness intervention could with fidelity implement the student curriculum more independently one year later.

Power Analyses. The primary goal of this research project was to estimate the preliminary effectiveness of the student mindfulness intervention on change in student EF and SEL. The

secondary goal was to explore whether participating in a mindfulness intervention and assisting with the implementation of the student-level mindfulness intervention would be sufficient training for fifth-grade teachers to implement the student intervention independently in the subsequent year with fidelity. The current paper focuses on the primary goal using data from the randomized sample.

A priori power analyses were conducted to determine the adequacy of the planned sample across the entire study (i.e., 40 classrooms with an expected 12 students per classroom on average). This article reports only on the randomized controlled trial which had a planned sample of 20 classrooms. Twenty-four classrooms were initially enrolled in this study, with three teachers withdrawing and no data collected on their students. Applying the same parameters as the *a priori* power analyses but with the actual sample for the randomized trial in OpDes software (Raudenbush, Spybrook, Congdon, Liu, Martinez, 2009), in a two-level random intercept model, resulted in power estimates of .18, .45 and .73 for small (δ=.2), small to medium (δ=.35) and medium (δ=.5) effect sizes, respectively, that increase to .23, .55 and .85 with an ICC of 0.05.

Classroom interventions. A major component of this project was the development of novel mindfulness-based interventions (MBIs) for 5th grade teachers and 5th grade students. Piloting and refinement of the curricula occurred during the year before data were collected for the current study, as part of a multi-year grant. Mindfulness-Based Stress Reduction (Kabat-Zinn, 2009) and a modified MBSR curriculum for teachers (Flook et al., 2013) formed the basis for the teacher training. Once the teacher training was drafted, its scope and sequence were used as a blueprint and adapted for 5th grade students (Appendix A).

All MBI curricula developers / instructors were experienced mindfulness practitioners (each with >10 years practice experience) and teachers (each with >5 years teaching experience). Importantly, they were all also former classroom teachers (>40 years combined experience) and as classroom teachers had integrated mindfulness practice into their pedagogy. After the initial curricula were developed, they were piloted with a small group of 5th grade teachers and their students in the year prior to the present study. Qualitative data collected from this pilot informed refinements to the curricula used in this research.

Beginning in the fall of the study year, teachers from classrooms assigned to the intervention took part in a 10-week, 75-minute per session MBI, with one half-day mindfulness intensive during their professional development time. The teacher training was focused on developing a personal mindfulness practice and did not include instruction in teaching mindfulness to students. The teacher and student interventions followed the same general structure and included mindfulness practices emphasizing awareness of body, breath, thought, and emotion as well as caring practices focused on generating feelings of goodwill and concern for others (Appendix A). The student intervention consisted of two weekly lessons of approximately 20-25 minutes each for 8 weeks (Appendices A & B). It was led by the same expert mindfulness instructors who taught the teacher intervention. The classroom teacher was present for student lessons and assisted the expert instructor in an apprenticeship model. All students in intervention classrooms received the intervention regardless of their status as research study participants but data was collected only on study enrolled students.

Testing procedure. As noted, pre-testing for students occurred between late January and early February, approximately one to two-months after the end of the teacher intervention and around two-weeks before student mindfulness training began. Student post-testing was conducted within

two weeks following the end of the student intervention in early spring. All testing was conducted in school on research team iPads supervised by research team members. Qualtrics® was used for questionnaires and the National Institutes of Health's cognitive toolbox iPad app was used for EF cognitive behavioral measures. End of year social-emotional learning grades were provided by the participating school districts.

Intervention fidelity. Fidelity of implementing the student curriculum was assessed through observations by two raters who were Mindfulness-Based Stress Reduction instructors and both had previous experience implementing mindfulness curricula for children in school settings. Fidelity raters monitored implementation of the curriculum and instructors' embodiment of the qualities of mindfulness using a measure of fidelity adapted for the study (Crane et al., 2013). Items on qualities of mindfulness (e.g., awareness, non-judging, acceptance, letting go, "in the moment") and teaching (e.g., responsiveness and flexibility, pace of lesson, skillful management of group process) were rated on a Likert scale from 0 (*disagree)* to 4 (*agree)* with higher scores indicating greater fidelity to the curriculum.

Fidelity raters observed lessons at weeks six, seven, and eight of the student intervention taught by each of the three mindfulness instructors. In addition to the same mindfulness instructors who co-led the teacher intervention, a third mindfulness instructor was involved in implementing the student intervention. The three mindfulness instructors who implemented the student intervention were highly skilled with equivalent training in mindfulness facilitation and 6 - 23 years of classroom teaching experience. Adherence to the curriculum was also monitored via weekly instructor meetings. Mindfulness instructors reviewed lesson content each week to confirm that the themes and practices for each lesson were taught according to a detailed version of the curriculum that outlined the key information, practices, inquiry and pace for each lesson.

In this way, both the quality and content of instruction reflected a high degree of fidelity to the curriculum.

Measures

Cognitive behavioral measures of executive functioning

The NIH Toolbox cognitive battery of behavioral tasks was administered via the NIH toolbox iPad app to measure executive functioning (EF).

Flanker task. To assess executive attention and inhibitory control, the child version of the Erikson Flanker task was used. The Flanker task presents five black arrows pointing right or left and instructs the participant to attend only the direction of the center arrow, hitting the button on the bottom right or left of the iPad screen that corresponds to the direction the center arrow is pointed. On congruent trials, all arrows point in the direction of the center arrow. On incongruent trials, the flanking arrows point in the opposite direction of the center arrow, presenting a visual conflict that the participant must overcome by inhibiting flanking arrow information and attending only to the center arrow. The task consists of 20 total trials and takes about 3 minutes to complete. Scores ranges from 0-10 and represents a combination of a reaction time scoring vector (0-5 points) and an accuracy scoring vector (0-5 points), with better accuracy and faster mean reaction time on correct trials scoring higher. In addition to the total score, mean reaction time on correct trials were examined as an indicator of improved attention. As reaction time measures are typically skewed, they were log transformed before analysis (Whelan, 2008).

Dimensional Change Card Sort task. The Dimensional Change Card Sort task was used to measure attentional set-shifting or cognitive flexibility (Akshoomoff et al., 2014; Weintraub et al., 2013). During the task, participants must rapidly and flexibly shift between sets of rules (Zelazo et al., 2013). Two images are presented that are the same on one dimension (e.g., a boat)

but differ on another (e.g., one is blue and the other is yellow). On one set of trials, participants are instructed to hit the button corresponding to the shape but in switch trials, the instructions change so that the participant is instructed to hit the button corresponding to color and then may in the next trial go back to matching on shape. Scores are computed in the same way as the Flanker task. Mean reaction time on correct trials were analyzed as an additional metric of increased attention (again log transformed for normality).

List Sort task. Linguistic working memory was measured using the List Sort task. The List Sort asks participants to properly sort sequenced stimuli provided visually and auditorily (Tulsky et al., 2014). Pictures of food and animals are presented; participants then sort in order of presentation along one dimension (e.g., animals only) and then along two dimensions (e.g., animals and then food). The task takes about 7 minutes to complete. Normed scores were analyzed with a mean of 100, a standard deviation of 15, and a maximum score of 140 (see Weintraub et al., 2013).

Teacher report measures

Teacher ratings of student social competence. Student's social competence was assessed through the Teacher Social Competence Scale (Conduct Problems Prevention Research Group, 1995). The scale is a teacher report measure comprised of two domains: a prosocial behavior domain (7 items, Cronbach's α=.94) and an emotion regulation domain (5 items, Cronbach's α=.90). Items in the prosocial behavior domain include "Listening carefully to others" and "Handling disagreements in a positive way." Emotion regulation items include "Stopping and calming down when excited or upset" and "Getting angry when provoked by other children (reverse scored)." Ratings are made on a 6-point Likert-like scale anchored by 0 (almost never)

and 5 (almost always). Higher scores represent greater teacher endorsement of student prosocial behaviors or emotion regulation, respectively.

Social-emotional learning grades. In both districts, social-emotional learning was assessed with 13-items that assessed students' abilities related to schoolwork (e.g., complete work on time, independently, carefully, take responsibility for work), behavior in school (e.g., follow rules, uses time wisely), and social interactions (e.g., works cooperatively with others). Items were rated on 1 (rarely) to 4 (almost all of the time/consistently) scale. The average of the 13-items was the social-emotional report card grade used in analyses with average scores corresponding to the scale presented above. Although both districts included items relating to schoolwork, behavior in school, and social interactions, the suburban district items weighted relatively more heavily toward self-regulation and academics whereas the urban school district items focused relatively more on peer social interactions. SEL grades were assigned by classroom teachers and measured at two times points. SEL grades from 4th grade (i.e., Spring; Cronbach's α=0.95) served as the baseline score and the final SEL grade from 5th grade (Spring; Cronbach's α=0.97) as the outcome.

Statistical models

Differential group attrition based on student data was inspected by constructing a dichotomous (Yes data/ No data) post-test variable for each outcome at post-test and regressing them on group in logistic regression models. To add confidence that any observed student-level effects were the result of the student-level intervention and not carryover effects of the teacher-level intervention, independent group (i.e., intervention / control) Welch's *t*-tests on the pre-test scores of all outcomes were estimated. Even though 21 classrooms are a small number of level-2 units for hierarchical linear modeling (Hox, 2010), ignoring the classroom nesting overstates the precision

of model estimates and therefore increases Type I error by not properly accounting for the dependencies in the student data (Raudenbush & Bryk, 2002). Therefore, data were modeled in hierarchal linear models (random intercept models). In all models, students were clustered within classroom and the post-test score of the outcome was regressed on a level-2 categorical group variable representing the contrast of interest (i.e., Control / Intervention), the pre-test score of the outcome variable, a district dummy variable, teacher years of teaching fifth grade, and student SES. The general model can be written as:

$$POST_{ij} = \gamma_{00} + \gamma_{01}*GROUP_j + \gamma_{02}*Years.teaching.fifth.grade_j + \gamma_{03}*\text{district}_j +$$

$$\gamma_{10}*PRE_{ij} + \gamma_{20}*\text{SES}_{ij} + u_{0j} + r_{ij}$$

or in two-level format as:

$$\text{Level-1: } POST_{ij} = \boldsymbol{\beta}_{0j} + \boldsymbol{\beta}_{1j}*PRE_{ij} + \boldsymbol{\beta}_{2j}*SES_{ij} + r_{ij}$$

$$\text{Level 2: } \boldsymbol{\beta}_{0j} = \gamma_{00} + \gamma_{01}*GROUP_j + \gamma_{02}* Years.teaching.fifth.grade_j + \gamma_{03}*\text{district}_j + u_{0j}$$

$$\boldsymbol{\beta}_{1j} = \gamma_{10}$$

where, controlling for covariates, γ_{00} reflects the average residual gain across classrooms in the control condition, γ_{01} represents the effect of the intervention (GROUP 0= wait-list control; 1=intervention), γ_{02} is the effect of years teaching fifth grade, γ_{03} is the effect of district, γ_{10} is the effect of the student baseline score (PRE), γ_{20} is the effect of student SES, u_{0j} is the level-2 (classroom) residual intercept and r_{ij} is the level-1 (student) residual. Missing data were handled under the missing at random assumption through maximum likelihood estimation. In addition to reporting on statistical significance at $p<.05$, effect size estimates are calculated by estimating a model-based effect size equivalent to Cohen's *d* (Cohen, 1992) for the group contrast of interest by dividing the group coefficient by the pooled pretest standard deviation. The computed effect size estimate represents the model predicted between group difference at post-test on the

outcome in standard deviation units. Because Cohen's (1988) interpretive rule of thumb that effects of 0.20, 0.50, and 0.80 standard deviations represent small, medium, and large magnitudes is arbitrary and may underestimate the importance of effects in educational context (e.g., grades; Kraft, 2020), Cohen's U3, which reflects the percentage of the intervention group with predicted post-test scores better than the average predicted control group student score, are also provided. The intraclass correlation coefficient (ICC) was calculated using empty models (i.e., no covariates) to provide information on the amount of outcome variance explained by the classroom/teacher. The lme4 package in R (Bates et al., 2015; R Core Team, 2021) was used to conduct primary analyses.

Results

At post-test, one participant (<1.0%) was missing teacher-rated prosociality and emotion regulation, three participants (1.0%) were missing data on the dimensional change card sort task, four participants (1.4%) were missing data on the flanker task, five participants (1.7%) were missing data on the list sort task, six participants (2.1%) were missing data on anxiety, and 17 participants (5.8%) were missing data on social-emotional report card grades. There were no differences in rates of missingness between the groups following logistic regression analyses (*p*s=0.292 to 0.996). Using independent Welch's *t*-tests, no statistically significant differences between groups on any pre-test score were observed (all *p*s>0.05). Descriptive statistics for student measures are presented in Table 2.

{INSERT Table 2. ABOUT HERE}

Implementation Fidelity

The MBI instructors were rated highly across all items on their implementation of the student intervention (*M*=3.92, range=3.71 - 4.00). All three instructors received similarly high

ratings of teaching fidelity (*M*=3.96, 3.92, 3.83). As a result of the weekly instructor meetings, all content was presented according to the planned scope and sequence of the training.

Executive Functioning

Flanker Task. The between group residualized gain on overall Flanker Task performance favored the intervention group but was not statistically significant (γ_{01}=0.11, *se*=0.10, *p*=0.289, *d*= 0.14, U3=55.6%), controlling for years teaching fifth grade, district (suburban is reference), SES (low is reference; γ_{02}=<0.01, *se*=0.01, *p*=0.962 ; γ_{02}=-<0.01 , *se*=0.11, *p*=0.974 ; γ_{20}=<-0.01, *se*=0.08, *p*= 0.956, respectively) and baseline Flanker performance γ_{10}=0.62, *se*=0.04, *p*<0.001. The between group residualized gain on log normalized Flanker RTs also favored the intervention group but was not statistically significant γ_{01}=-0.05, *se*=0.03, *p*=0.107, *d*=-0.17, U3=56.8%, 5.65% reduction in reaction time speed at post-test (Figure 2), controlling for years teaching fifth grade, district and SES (γ_{02}=<-0.01, *se*=<0.01, *p*=0.834 ; γ_{02}=0.01 , *se*=0.03, *p*=0.861 ; γ_{20}=-0.02, *se*=0.03, *p*= 0.473, respectively) and baseline log normalized Flanker RT γ_{10}=0.65, *se*=0.04, *p*<0.001. ICCs on Flanker and Flanker RTs were 0.02 and 0.01, respectively.

Dimensional Change Card Sort Task. Students in the intervention group demonstrated significant residualized gains on the Dimensional Change Card Sort task γ_{01}=0.30, *se*=0.09, *p*=0.001, *d*=0.32, U3=62.7% (Figure 2), controlling for years teaching fifth grade, district and SES (γ_{02}=0.01, *se*=0.01, *p*=0.203 ; γ_{02}=0.23 , *se*=0.10, *p*=0.028 ; γ_{20}=<-0.01, *se*=0.09, *p*= 0.959, respectively) and baseline DCCS performance γ_{10}=0.47, *se*=0.05, *p*<0.001. The ICCs was 0.03. A similar magnitude reduction (i.e., improvement) on average log normalized DCCS RTs favoring the intervention group at post-test (Figure 2) was observed γ_{01}=-0.07, *se*=0.04, *p*=0.068, *d*=-0.26, U3=60.3%, 7.57%, controlling for years teaching fifth grade, district and SES (γ_{02}=<-0.01, *se*=<0.01, *p*=0.245 ; γ_{02}=-0.02 , *se*=0.04, *p*=0.628 ; γ_{20}=-0.04, *se*=0.03, *p*= 0.160

respectively) and baseline log normalized DCCS RT γ_{10}=0.71, *se*=0.05, *p*<0.001. The ICC was 0.04.

List Sort Task. There was not a significant effect of group on the List Sort task γ_{01}=0.03, *se*=1.63, *p*=0.868, *d*<0.01, U3=50.0%, controlling for years teaching fifth grade, district and SES (γ_{02}=0.16, *se*=0.19, *p*=0.414 ; γ_{02}=3.72 , *se*=1.79, *p*=0.051 ; γ_{20}=1.11, *se*=1.40, *p*= 0.432 respectively) and baseline List Sort performance γ_{10}=0.54, *se*=0.05, *p*<0.001. The ICC was 0.05.

{INSERT Figure 2. ABOUT HERE}

Teacher Ratings of Student Social Competence

There were non-statistically significant, small magnitude residualized gains favoring the intervention group on teacher-rated emotion-regulation γ_{01}=0.23, *se*=0.16, *p*=0.172, *d*=0.21, U3=58.3%, controlling for years teaching fifth grade, district and SES (γ_{02}=0.01, *se*=0.02, *p*=0.575 ; γ_{02}=0.14 , *se*=0.17, *p*=0.430; γ_{20}=0.04, *se*=0.08, *p*= 0.613, respectively) and baseline emotion regulation γ_{10}=0.81, *se*=0.03, *p*<0.001. The ICC was 0.21.

Similarly, we observed non-statistically significant, small magnitude residualized gains favoring the intervention group on teacher-rated prosociality γ_{01}=0.26, *se* = 0.19, *p*=0.180, *d*=0.26, U3=60.3% (Figure 3), controlling for years teaching fifth grade, district and SES (γ_{02}=<0.01, *se*=0.02, *p*=0.890 ; γ_{02}=0.15 , *se*=0.19, *p*0.438 ; γ_{20}=<0.01, *se*=0.07, *p*= 0.950 respectively) and baseline prosociality grades γ_{10}=0.86, *se*=0.03, *p*<0.001.. The ICC for prosociality was 0.35.

Social-Emotional Learning Grades

The intervention group demonstrated small magnitude, statistically significant residualized gains on SEL grades γ_{01} = 0.15, *se*=0.07, *p*=0.041, *d*=0.29, U3=61.4%, controlling for years teaching fifth grade, district and SES (γ_{02}=0.02, *se*=0.01, *p*=0.038 ; γ_{02}=0.58 , *se*=0.08,

$p<0.001$; $\gamma_{20}=0.06$, $se=0.04$, $p= 0.112$ respectively) and prior year SEL grades $\gamma_{10}=0.54$, $se=0.05$, $p<0.001$. The ICC was 0.59.

{INSERT Figure 3. ABOUT HERE}

Discussion

Students in classrooms assigned to the mindfulness intervention showed significant gains on an objective computerized task of executive functioning and end of year SEL report card grades compared to students in the control group. Specifically, students in the mindfulness group showed improvements in cognitive flexibility, as reflected in their overall performance on the DCCS, and social-emotional learning, as evidenced by their end of year SEL grades controlling for prior year SEL grades. Small magnitude, non-statistically significant improvements were observed on both DCCS and Flanker RTs. Similarly, gains on teacher-reported emotion-regulation and prosociality were not statistically significant, but small magnitude improvements favoring the intervention were observed.

By using randomization and objective measures to examine the impact of mindfulness training, this study helps address the need for more methodologically rigorous research with school age students. In addition, we utilized an adapted version of a widely researched mindfulness intervention to distill mindfulness as the active ingredient in this intervention. Taken altogether, the current findings extend research on school-based mindfulness by replicating previous results regarding improvements in EF within a different sample and documenting a longer-term impact of mindfulness training by assessing end-of-year report card grades of social emotional learning.

The intervention used in the current study consisted of 16 sessions (twice per week) for a total of approximately 400 minutes of instruction. The present program offers a condensed

mindfulness training for students that is relatively low-cost and time efficient. Most public schools in the US require between 900-1050 instructional hours in a school year for 5th graders (IES, nd). The current intervention takes less than 1% of allotted instructional time to implement and yields benefits for students.

The observed improvements in executive functioning have potentially important implications for children's cognitive development. Specifically, students in the mindfulness group showed improvements in cognitive flexibility, as reflected in their overall performance on the DCCS, an objective computerized task. Improvements in inhibitory control reaction time on the Flanker task were marginally significant and consistent with results from Schonert-Reichl et al. (2015) – a randomized study with a sample of 99 students in the same age range – showing benefit of a mindfulness-based intervention on student inhibitory control. The magnitude of the observed change (d=0.14; Cohen, 1988; Kraft, 2020) translates into around 57% of the intervention group performing better at post-test than the average control group student.

The observed improvements on EF occurred amidst a developmental period during which EFs rapidly improve (Anderson, 2002). Thus, the observed effects can be thought of as an acceleration of a crucial on-going developmental process. EFs are a core constituent of self-regulation. Children with greater self-control demonstrate better academic and social functioning over the course of development and into adulthood (Mischel et al., 1989). When placed on a gradient, greater self-control as a child predicts greater health, financial security, fewer drug or alcohol problems, and a lower likelihood of criminal conviction as an adult, after controlling for intelligence and childhood SES (Moffitt et al., 2011). The notion of a self-control gradient is particularly salient to the present findings. One way of interpreting observed intervention group improvements on EFs is as a shift in intervention group students' location on the sample gradient

of self-control. An implication from longitudinal research is that children whose location on the self-control gradient improves across childhood are predicted to have correspondingly better outcomes across a host of meaningful life indicators decades later (Moffitt et al., 2011). This suggests that interventions which improve self-control may produce measurable benefits across a continuum, such that even small increases early in life, which become cumulative across the lifespan, could shift the entire distribution of salient outcomes to yield societal benefits. Intervening during a crucial developmental period such as later-childhood, as was the case in this research, may further facilitate a substantive shift in the life trajectory even when the immediate benefits are relatively smaller in magnitude.

Students in the mindfulness intervention also showed significant gains on social-emotional learning, as evidenced by their end of year SEL grades controlling for prior year SEL grades. A considerable amount of the variance in teacher reported outcomes including SEL grades was explained by the teacher. It is important to note that prior year grades were given by a different teacher, and it would be highly unusual for a teacher a year later to review prior year grades from a different classroom when giving end of year marks. While we cannot rule out the possibility that the observed teacher reported SEL gains were the result of teacher reporting bias, at least on SEL grades, this explanation seems unlikely to account for all of the observed benefits. Additionally, teacher perceptions of students matter a great deal to student educational outcomes (Friedrich et al., 2015), including how students view themselves and the education context, which has implications for student learning (Hinnant, O'Brien, & Gharazaian, 2009). Teacher perceptions of students are also implicated in race-based educational inequities (Weinstein, Gregory, & Strambler, 2004). Therefore, enhancing teacher perceptions of students has the potential to favorably wield influence on a student's educational trajectory.

An argument against teacher reporting bias in this study is that there were not significant differences on teacher ratings of student social emotional competence at post-test; teacher ratings of student social-emotional growth were only evident months after the intervention on end of year social-emotional learning grades. However, in order to more definitively rule out teacher bias in reporting as a driver of the observed changes. including raters who are blind to condition, or other objective measures of these outcomes would be needed to provide convergence.

In contrast with other EFs, working memory did not show change in this study. There are two main differences compared to other mindfulness intervention studies that have detected changes in working memory, one is that other studies focused on adult populations and second, they used tasks that have less emphasis on verbal working memory (Jha et al., 2019). The list sort task used in this study was part of the NIH battery and is specifically a measure of verbal working memory. It is possible that the present intervention did not affect verbal working memory but could have impacted visuospatial or episodic working memory (Baddeley, 2003). Visuospatial working memory is important to the manipulation of numbers and implicated in a number of STEM related fields making assessment of this component of working memory an important area for future research.

Limitations and Future Directions

A question that arises is whether the observed effects are due to the student training alone or the combination of teacher and student training. It is possible that the teacher-level intervention led to trickle-down benefits on students. However, there was no evidence that intervention and control group students differed on any measure at the student pre-test assessment that occurred approximately a month after the end of the teacher intervention. We are not able to disentangle whether the observed results are solely a function of the student

intervention or if perhaps the teacher intervention interacted with the student intervention over time. The lack of baseline student differences lends support to the interpretation that the effects presented here were not driven primarily by the teacher intervention. In addition, other research involving teacher intervention has observed no effects on students during the year of the teacher intervention, but student-level effects emerged the year after when teachers presumably were better able to integrate their learning into practice (e.g., Gregory, Allen, Mikami, Hafen, & Pianta, 2015). Examining the relative contribution of teacher and student level interventions would be possible by comparing a student only intervention with a combined teacher and student intervention.

Another limitation of the current study was the relatively small number of level 2 units. Relatedly, three of the 24 teachers who initially enrolled withdrew prior to intervention onset. This precluded recruiting their students into the study and estimating true intention-to-treat estimates on the students of all teachers who were randomly assigned. The fact that all three teachers who withdrew were from the same school and decided to withdraw in unison may indicate les risk of bias, but it is a limitation of the present work. In terms of statistical power, the study was able to detect medium to large effects and smaller effects may have gone undetected. Despite this limitation, the effect sizes associated with the outcomes could provide a helpful benchmark for future investigators to reference. Scaling research that is rigorously designed to include a larger number of classrooms will allow the field to continue to advance. In addition, including additional follow-up time points beyond the current academic year would be useful for assessing the persistence of effects. In order to promote longer term impact, researchers should consider ways to reinforce and bolster the practices once they are learned.

Considering the nascent state of rigorous research on student mindfulness interventions,

evaluating interventions that differ in terms of dosage and content foci remains critically important. For example, no rigorous research has yet evaluated the relative impact of a mindfulness program with evidence of efficacy when it is implemented by expert instructors (as in the present research) versus classroom teachers trained to implement the intervention. Future research on this question is essential to understanding the potential for scaling-up mindfulness interventions and for implementing mindfulness interventions as universal prevention strategies.

Possible variations for future research could investigate dosage to determine the impact of longer or shorter interventions on student outcomes. Additionally, an intriguing possibility that has not been examined thus far is whether mindfulness training may make students more receptive to other types of learning. Researchers could examine in a factorial design the impact of mindfulness followed by SEL training or SEL followed by mindfulness training, in addition to other permutations that can shed light on optimizing outcomes for students. Future work should also investigate impacts across a range of grade levels from pre-K to professional training. Many questions remain about dosage, individual differences, and sustainability of training. These findings provide a new data point in a small but growing evidence base on the utility of school-based mindfulness for student cognitive and social emotional skills enhancement.

The results of this study provide evidence for educators and other stakeholders who are seeking research-based methods to promote whole child development. These findings can further encourage stakeholders to embrace an integrated perspective on social, emotional and cognitive functioning. A growing body of research shows how bound together these areas of development are and is consistent with a whole child perspective on development. Practitioners and policy makers alike can advance the field by advocating for research-based approaches that address children holistically. There is considerable evidence demonstrating the importance of social

emotional learning for children's development that cannot be separated from children's cognitive development. This study provides empirical evidence for a practical approach that shows promise for enhancing both social emotional and cognitive faculties in childhood.

Acknowledgments

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A140479 to Lisa Flook and Richard J. Davidson, and a National Academy of Education / Spencer Foundation postdoctoral fellowship awarded to Matthew J. Hirshberg. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education. We are grateful to the teachers and students who participated in this study; Jane Sachs for project management; Lisa Thomas-Prince for her kindness and skill in implementing the intervention; and Mark Greenberg for helpful comments on an earlier draft of this manuscript.

Disclosure Statement

The authors declare that they have no conflict of interests.

Ethical Approval

This study was approved by the Institutional Review Board of University of Wisconsin-Madison (#2014-0605) and participating school district review committees.

Data Sharing Declaration

The datasets generated and analyzed during the current study are available from the corresponding author upon request.

Table 1. Participant Demographics

Table 2. Descriptive Statistics

Table 1. Participant Demographics

	Intervention (n / %)	Control (n / %)	Baseline Group Contrast χ^2/ p
Student race			χ^2=5.71, p=0.222
Asian / Pacific Islander	14 (9.09)	12 (8.70)	
African American	29 (18.83)	16 (11.59)	
Hispanic	23 (14.94)	15 (10.87)	
White	79 (51.30)	89 (64.49)	
More than one race	3 (1.95)	2 (1.45)	
Student gender			χ^2=0.019, p=0.890
Female	81 (52.60)	76 (55.07)	
Male	68 (44.16)	60 (43.48)	
Socioeconomic status			χ^2=0.79, p=0.373
Low	59 (38.31)	47 (34.06)	
High	87 (56.49)	89 (63.69)	
District			χ^2=3.13, p=0.077
Suburban	70 (45.45)	78 (56.52)	
Urban	84 (54.55)	60 (43.48)	

Note. Low socioeconomic status was defined as living in a household where no caregiver has obtained a college degree. High socioeconomic status was defined as living in a household where one or more caregivers had obtained a college degree. Student race and gender do not sum to 100% because of missingness. t-test were Welch's t-tests. Chi-square tests used Yates continuity correction.

Table 2. Descriptive Statistics

	Intervention		Control		Baseline Group Contrast
	Time 1	**Time 2**	**Time 1**	**Time 2**	***t* / *p***
Outcomes	**Mean (*SD*)**	**Mean (*SD*)**	**Mean (*SD*)**	**Mean (*SD*)**	
NIH Flanker	8.36 (0.94)	8.64 (0.75)	8.41 (0.79)	8.58 (0.86)	t= 0.56, p=0.573
NIH Flanker RT (ms)	-0.15 (0.33)	-0.26 (0.25)	-0.17 (0.27)	-0.23 (0.30)	t=-1.15, p=0.252
NIH DCCS	8.45 (0.90)	8.64 (0.81)	8.47 (0.96)	8.45 (0.82)	t=0.18 , p=0.855
NIH DCCS RT (ms)	-0.27 (0.27)	-0.27 (0.27)	-0.26 (0.26)	-0.23 (0.29)	t=0.28, p=0.778
NIH List Sort	96.77 (11.84)	99.18 (11.76)	98.32 (12.29)	101.56 (12.66)	t=1.10 , p=0.274
TSC Prosocial behavior	3.52 (0.99)	3.97 (0.99)	3.50 (1.00)	3.78 (1.01)	t=-0.19 , p=0.853
TSC Emotion regulation	3.50 (1.14)	3.83 (1.07)	3.52 (1.12)	3.70 (1.04)	t=0.17 , p=0.863
SEL Grades	3.18 (0.50)	3.27 (0.55)	3.22 (0.54)	3.31 (0.58)	t=0.52 , p=0.605

Note: RT = log transformed reaction time; ms = millisecond. DCCS = Dimensional Change Card Sort task. TSC = Teacher Social Competence. t-test were Welch's t-tests. Chi-square tests used Yates continuity correction.

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) Diagram

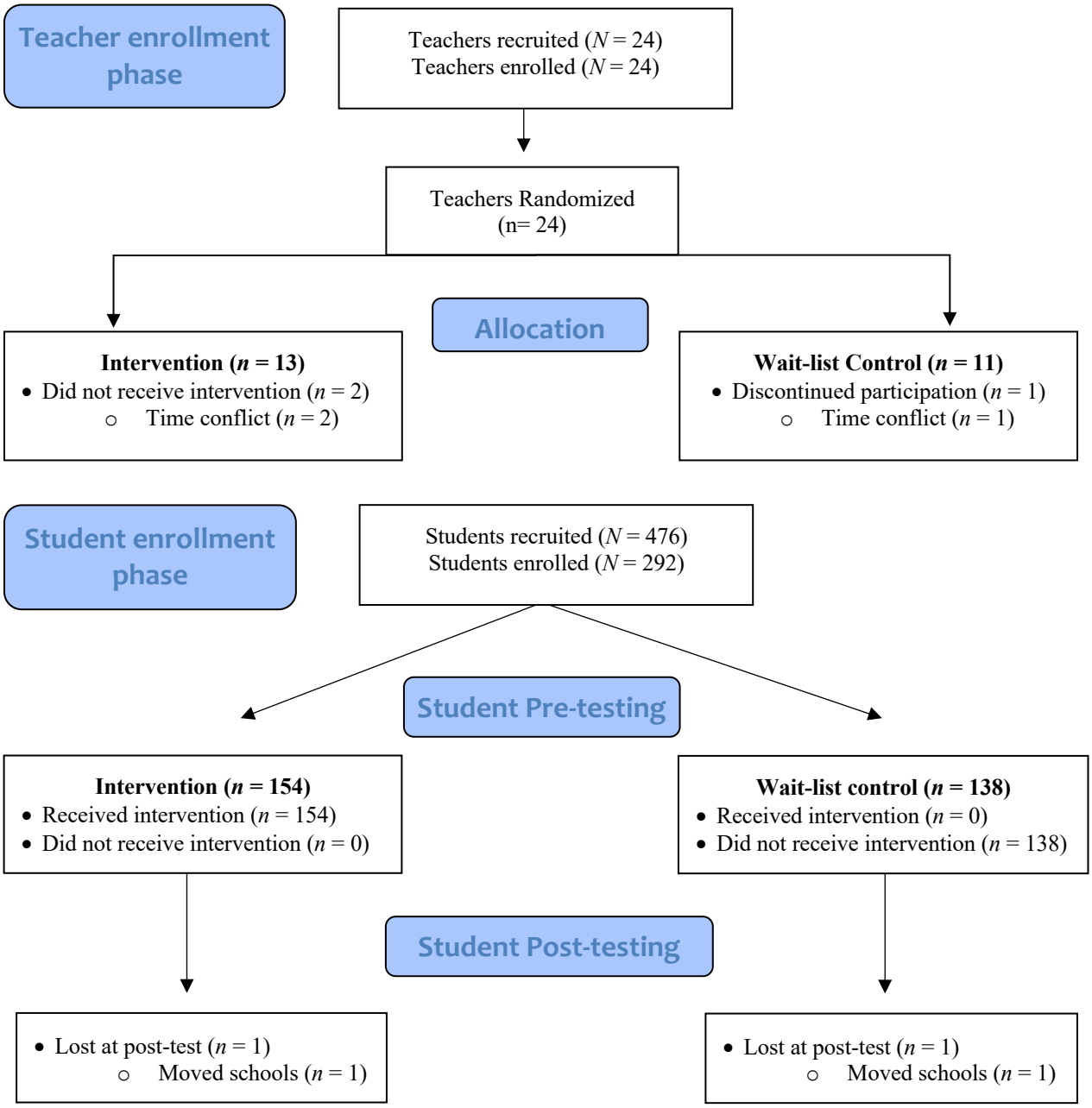
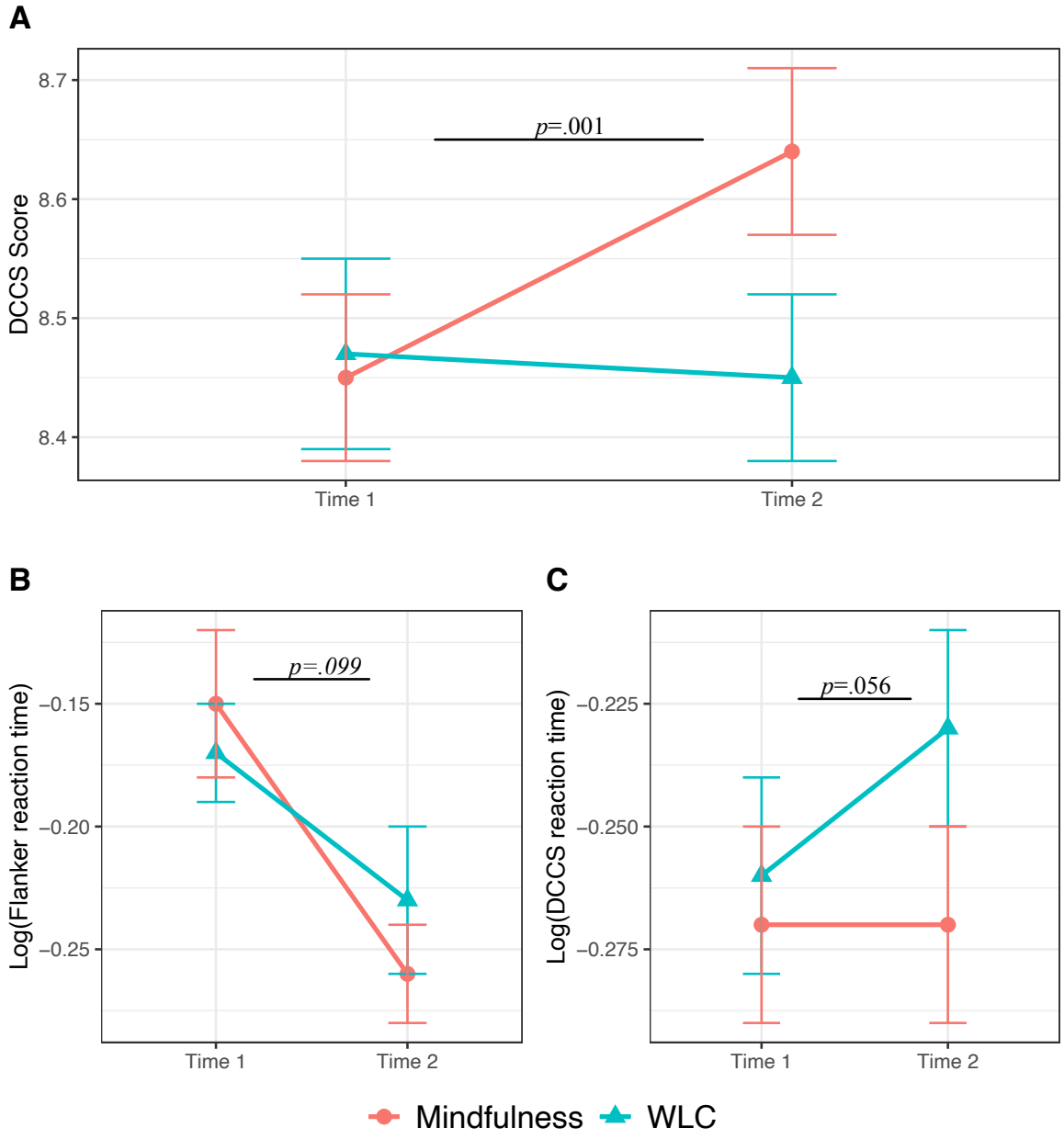
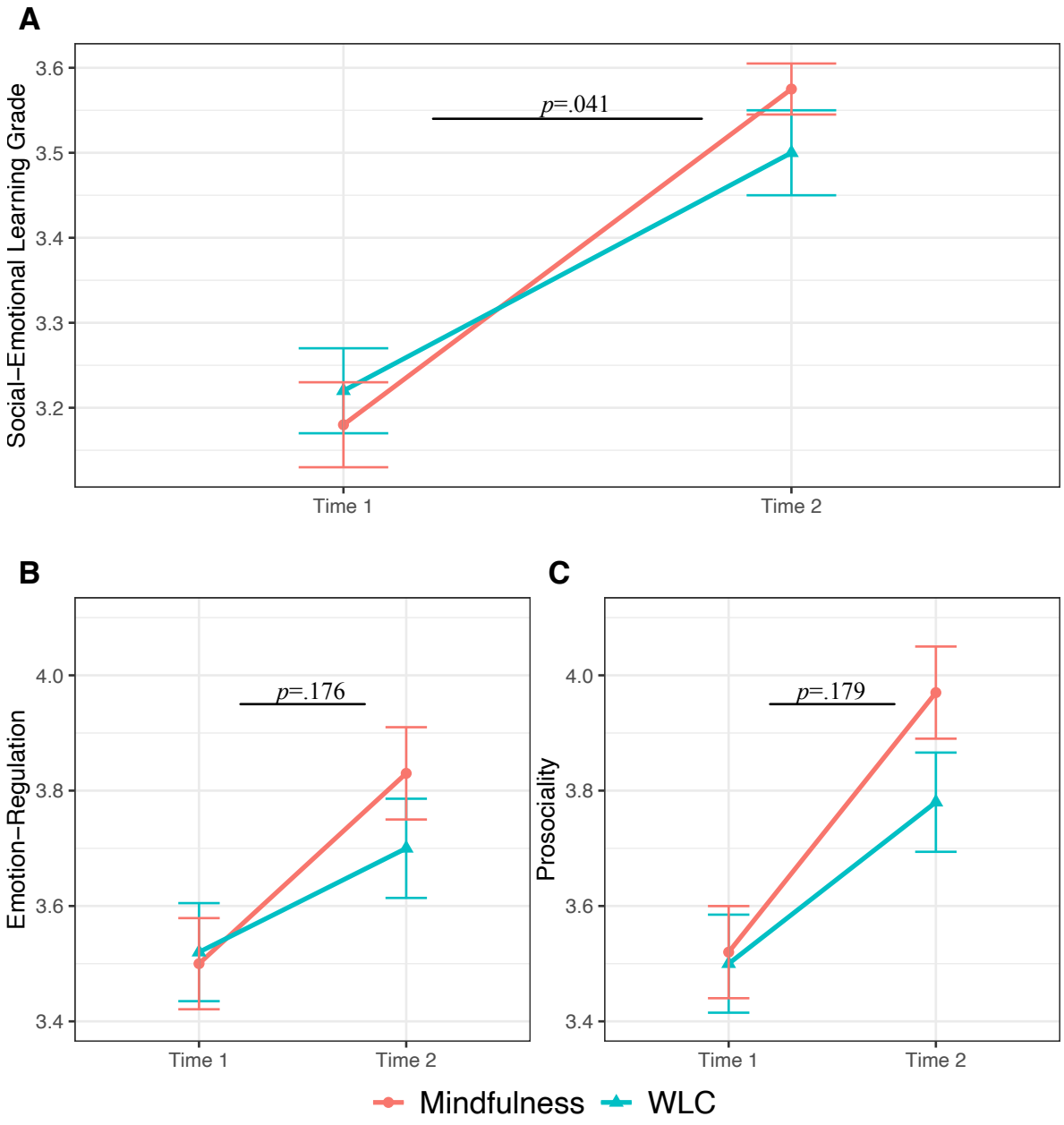


Figure 2. Student Mindfulness Training Effects on Executive Function



Note: Results are from analyses using Hierarchical Linear Modeling. A. Dimensional Change Card Sort Task from the NIH Cognitive Toolbox. B. Natural of reaction time on correct Flanker Task trials from the NIH Cognitive Toolbox. C. Natural log of reaction time on correct Dimensional Change Card Sort Task trials from the NIH Cognitive Toolbox. Time 1 = pre-test. Time 2 = post-intervention.

Figure 3. Student Mindfulness Training Effects on Social-Emotional Learning Grades, and Teacher-Rated Emotion-Regulation and Prosociality



Note: Results are from analyses using Hierarchical Linear Modeling. A. Teacher reported social-emotional learning grade. Time 1 = spring of preceding year. Time = spring of current year. B. Teacher reported emotion regulation. C. Teacher reported prosocial behavior. For B. and C; Time 1 = pre-test. Time 2 = post-intervention.

References

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology, 8*(2), 71-82.

Barkley, R. A. (2012). Executive Functions: What They Are, How They Work, and Why They Evolved. New York: Guilford Publications.

Bass, R. V., & Good, J. W. (2004, June). Educare and educere: Is a balance possible in the educational system? In *The educational forum* (Vol. 68, No. 2, pp. 161-168). Taylor & Francis Group.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models Usinglme4. Journal of Statistical Software, 67(1).

Berry, D. R., Hoerr, J. P., Cesko, S., Alayoubi, A., Carpio, K., Zirzow, H., Walters, W., Scram, G., Rodriguez, K., & Beaver, V. (2020). Does Mindfulness Training Without Explicit Ethics-Based Instruction Promote Prosocial Behaviors? A Meta-Analysis. Personality and Social Psychology Bulletin, 46(8), 1247–1269.

Blair, C. & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78*(2), 647-663.

Bottiani, J. H., Bradshaw, C. P., & Mendelson, T. (2017). A multilevel examination of racial disparities in high school discipline: Black and white adolescents' perceived equity, school belonging, and adjustment problems. *Journal of Educational Psychology*, *109*(4), 532.

Bottiani, J. H., Duran, C. A., Pas, E. T., & Bradshaw, C. P. (2019). Teacher stress and burnout in urban middle schools: Associations with job demands, resources, and effective classroom practices. *Journal of School Psychology*, *77*, 36-51.

Burchinal, M. R., Peisner-Feinberg, E., Pianta, R., & Howes, C. (2002). Development of academic skills from preschool through second grade: Family and classroom predictors of developmental trajectories. *Journal of School Psychology*, *40*(5), 415-436.

Carsley, D., Khoury, B., & Heath, N. L. (2017). Effectiveness of Mindfulness Interventions for Mental Health in Schools: A Comprehensive Meta-analysis. *Mindfulness*, 1–15.

CASEL (n.d.). What is SEL? A systemic framework. https://casel.org/what-is-sel/

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Conduct Problems Prevention Research Group [CPPRG]. (1995). Teacher - Social Competence

Scale. Available from the Fast Track Project Web site, http://www.fasttrackproject.org

Corrigan, N. M., Yarnykh, V. L., Hippe, D. S., Owen, J. P., Huber, E., Zhao, T. C., & Kuhl, P. K. (2021). Myelin development in cerebral gray and white matter during adolescence and late childhood. *NeuroImage*, *227*, 117678.

Crosnoe, R. & Elder Jr, G. H. (2004). Family dynamics, supportive relationships, and educational resilience during adolescence. *Journal of Family issues*, *25*(5), 571-602.

Crosnoe, R., Johnson, M. K., & Elder Jr, G. H. (2004). Intergenerational bonding in school: The behavioral and contextual correlates of student-teacher relationships. *Sociology of education*, *77*(1), 60-81.

ESSA. (n.d.). Every Student Succeeds Act. https://www.ed.gov/esea

Dahl, R.E. (2004). Adolescent brain development: A period of vulnerabilities and opportunities.

Keynote address. Annals of the New York Academy of Sciences, 1021, 1-22

Dahl, R., Suleiman, A., Luna, B., Choudhury, S., Noble, K., Lupien, S. J., ... & Uncapher, M. R. (2017). The Adolescent Brain: A second window to opportunity. Retrieved from: https://repositorio.minedu.gob.pe/bitstream/handle/20.500.12799/5746/The%20Adolescent%20Brain%20A%20second%20window%20to%20opportunity.pdf?sequence=1

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *24*(2), 97-140.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959-964.

Domitrovich, C. E., Durlak, J. A., Staley, K. C., & Weissberg, R. P. (2017). Social-emotional competence: An essential factor for promoting positive adjustment and reducing risk in school children. Child development, 88(2), 408-416.

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development*, *82*(1), 405-432.

Finn, C.E. & Hess, F.M. (2019). *What Social and Emotional learning Needs to Succeed and Survive*. Washington, DC: American Enterprise Institute.

Flook, L., Smalley, S. L., Kitil, M. J., Galla, B. M., Kaiser-Greenland, S., Locke, J., ... & Kasari, C. (2010). Effects of mindful awareness practices on executive functions in elementary school children. *Journal of applied school psychology*, *26*(1), 70-95.

Fraser, B. J., McRobbie, C. J., & Fisher, D. L. (1996, April). Development, validation and use of personal and class forms of a new classroom environment instrument. Paper presented at the annual meeting of the American Educational Research Association, New York.

Friedrich, A., Flunger, B., Nagengast, B., Jonkmann, K., & Trautwein, U. (2015). Pygmalion effects in the classroom: Teacher expectancy effects on students' math achievement. *Contemporary Educational Psychology*, *41*, 1–12.

Gershenson, S., Holt, S. B., & Papageorge, N. W. (2016). Who believes in me? The effect of student–teacher demographic match on teacher expectations. *Economics of Education Review*, *52*, 209-224.

Goldberg, S. B., Riordan, K. M., Sun, S., & Davidson, R. J. (2022). The empirical status of mindfulness-based interventions: A systematic review of 44 meta-analyses of randomized controlled trials. *Perspectives on psychological science*, *17*(1), 108-130.

Gregory, A., Allen, J. P., Mikami, A. Y., Hafen, C. A., & Pianta, R. (2015). Eliminating the racial disparity in classroom exclusionary discipline. Journal of Applied Research on Children: Informing Policy for Children at Risk, 5(2), 12.

Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of psychosomatic research*, *57*(1), 35-43.

Hackman, D. A., & Farah, M. J. (2009). Socioeconomic status and the developing brain. *Trends in Cognitive Sciences*, *13*(2), 65-73.

Hamre, B. K., & Pianta, R. C. (2001). Early teacher–child relationships and the trajectory of children's school outcomes through eighth grade. *Child Development*, *72*(2), 625-638.

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school years. *Journal of Educational Psychology, 101*, 662–670.

Hirshberg, M. J., Flook, L., Enright, R. D., & Davidson, R. J. (2020). Integrating mindfulness and connection practices into preservice teacher education improves classroom practices. Learning and Instruction, 66, 101298.

Hox, J. J. (2013). Multilevel regression and multilevel structural equation modeling. *The Oxford handbook of quantitative methods*, *2*(1), 281-294.

Huang, F. L. (2018). Multilevel modeling myths. *School Psychology Quarterly*, *33*(3), 492–499.

Hughes, J. N., & Kwok, O. M. (2006). Classroom engagement mediates the effect of teacher–student support on elementary students' peer acceptance: A prospective analysis. *Journal of School Psychology*, *43*(6), 465-480.

IES (nd). State Education Practices. Table 1.1 Minimum number of instructional days and hours in the school year by state: 2020. https://nces.ed.gov/programs/statereform/tab1_1-2020.asp

Jennings, P. A., Brown, J. L., Frank, J. L., Doyle, S., Oh, Y., Davis, R., ... & Greenberg, M. T. (2017). Impacts of the CARE for Teachers program on teachers' social and emotional competence and classroom interactions. *Journal of Educational Psychology*, *109*(7), 1010.

Jha, A. P., Denkova, E., Zanesco, A. P., Witkin, J. E., Rooks, J., & Rogers, S. L. (2019). Does mindfulness training help working memory 'work' better? *Current Opinion in Psychology*, *28*, 273-278.

Kabat-Zinn, J. (2013). Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness. New York: Bantam Books.

Kaplan, S., & Berman, M. G. (2010). Directed Attention as a Common Resource for Executive Functioning and Self-Regulation. *Perspectives on Psychological Science*, *5*(1), 43–57.

Kassai, R., Futo, J., Demetrovics, Z., & Takacs, Z. K. (2019). A meta-analysis of the experimental evidence on the near-and far-transfer effects among children's executive function skills. *Psychological Bulletin*, *145*(2), 165.

Khoury, B., Sharma, M., Rush, S. E., & Fournier, C. (2015). Mindfulness-based stress reduction for healthy individuals: A meta-analysis. *Journal of psychosomatic research*, *78*(6), 519-528.

Kish, L. (1965). *Survey sampling*. John Wiley & Sons. New York.

Klimecki, O. M., Leiberg, S., Lamm, C., & Singer, T. (2012). Functional neural plasticity and associated changes in positive affect after compassion training. *Cerebral cortex*, *23*(7), 1552-1561.

Klingbeil, D. A., Renshaw, T. L., Willenbrink, J. B., Copek, R. A., Chan, K. T., Haddock, A., ... & Clifton, J. (2017). Mindfulness-based interventions with youth: A comprehensive meta-analysis of group-design studies. *Journal of school psychology*, *63*, 77-103.

Kilpatrick, L. A., Suyenobu, B. Y., Smith, S. R., Bueller, J. A., Goodman, T., Creswell, J. D., ... & Naliboff, B. D. (2011). Impact of mindfulness-based stress reduction training on intrinsic brain connectivity. *Neuroimage*, *56*(1), 290-298.

Kraft, M. A. (2020). Interpreting effect sizes of education interventions. Educational Researcher, 49(4), 241–253.

Lai, M. H., & Kwok, O. (2015). Examining the rule of thumb of not using multilevel modeling:

The “design effect smaller than two” rule. *The Journal of Experimental Education*, *83*(3), 423–438.

Laube, C., van den Bos, W., & Fandakova, Y. (2020). The relationship between pubertal hormones and brain plasticity: Implications for cognitive training in adolescence. Developmental cognitive neuroscience, 42, 100753.

Lutz A., Slagter H.A., Dunne J.D., & Davidson, R.J. (2008) Meditation and the regulation of attention and emotion. *Trends in Cognitive Sciences,* 12(4), 163-169.

Melby-Lervåg, M., & Hulme, C. (2013). Is working memory training effective? A meta-analytic review. Developmental psychology, 49(2), 270.

Melby-Lervåg, M., Redick, T. S., & Hulme, C. (2016). Working Memory Training Does Not Improve Performance on Measures of Intelligence or Other Measures of “Far Transfer”: Evidence From a Meta-Analytic Review. *Perspectives on Psychological Science*, *11*(4), 512–534.

Mendelson, T., Greenberg, M. T., Dariotis, J. K., Gould, L. F., Rhoades, B. L., & Leaf, P. J. (2010). Feasibility and preliminary outcomes of a school-based mindfulness intervention for urban youth. *Journal of abnormal child psychology*, *38*(7), 985-994.

Merikangas, K. R., Nakamura, E. F., & Kessler, R. C. (2009). Epidemiology of mental disorders in children and adolescents. *Dialogues in clinical neuroscience, 11, 7-20,*

Mischel, W., Shoda, Y., & Rodriguez, M.L. (1989). Delay of gratification in children. *Science, 244*(4907), 933-938.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.

Moffitt, T.E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R.J., Harrington, H., et al. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences, 108*(7), 2693-2698.

Mrazek, M. D., Franklin, M. S., Phillips, D. T., Baird, B., & Schooler, J. W. (2013). Mindfulness training improves working memory capacity and GRE performance while reducing mind wandering. *Psychological Science*, *24*(5), 776-781.

O’Connor, E., & McCartney, K. (2007). Examining teacher–child relationships and achievement as part of an ecological model of development. *American Educational Research Journal*, *44*(2), 340-369.

Quach, D., Mano, K. E. J., & Alexander, K. (2016). A randomized controlled trial examining the effect of mindfulness meditation on working memory capacity in adolescents. *Journal of Adolescent Health*, *58*(5), 489-496.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Sage.

Roeser, R. W., Schonert-Reichl, K. A., Jha, A., Cullen, M., Wallace, L., Wilensky, R., ... & Harrison, J. (2013). Mindfulness training and reductions in teacher stress and burnout: Results from two randomized, waitlist-control field trials. *Journal of Educational Psychology*, *105*(3), 787.

Roorda, D. L., Koomen, H. M., Spilt, J. L., & Oort, F. J. (2011). The influence of affective teacher–student relationships on students' school engagement and achievement: A meta-analytic approach. *Review of Educational Research*, *81*(4), 493-529.

Sabol, T. J., & Pianta, R. C. (2012). Recent trends in research on teacher-child relationships. *Attachment and Human Development*, *14*(3), 213-231.

Schonert-Reichl, K. A., Oberle, E., Lawlor, M. S., Abbott, D., Thomson, K., Oberlander, T. F., & Diamond, A. (2015). Enhancing cognitive and social–emotional development through a simple-to-administer mindfulness-based school program for elementary school children: A randomized controlled trial. *Developmental Psychology*, *51*(1), 52.

Sibinga, E. M., Webb, L., Ghazarian, S. R., & Ellen, J. M. (2016). School-based mindfulness instruction: an RCT. *Pediatrics*, *137*(1), e20152532.

Sisk, C. L., & Foster, D. L. (2004). The neural basis of puberty and adolescence. *Nature Neuroscience*, *7*(10), 1040–1047.

Spielberger, C. (1973). *Manual for the State-Trait Anxiety Inventory for Children*. Palo Alto, CA: Consulting Psychologists Press.

Taylor, R. D., Oberle, E., Durlak, J. A., & Weissberg, R. P. (2017). Promoting Positive Youth Development Through School-Based Social and Emotional Learning Interventions: A Meta-Analysis of Follow-Up Effects. *Child Development*, *88*(4), 1156–1171.

Waters, L., Barsky, A., Ridd, A., & Allen, K. (2015). Contemplative Education: A Systematic, Evidence-Based Review of the effect of Meditation Interventions in Schools. *Educational Psychology Review*, *27*(1), 103–134.

Weinstein, R. S., Gregory, A., & Strambler, M. J. (2004). Intractable self-fulfilling prophecies fifty years after Brown v. Board of Education. *American Psychologist*, *59*(6), 511.

Weintraub, S., Dikmen, S. S., Heaton, R. K., Tulsky, D. S., Zelazo, P. D., Bauer, P. J., …

Gershon, R. C. (2013). Cognition assessment using the NIH Toolbox. *Neurology*, *80*(11 Suppl 3), S54-64.

Weng, H. Y., Fox, A. S., Shackman, A. J., Stodola, D. E., Caldwell, J. Z. K., Olson, M. C., Rogers, G. M., & Davidson R. J. (2013). Compassion training alters altruism and neural responses to suffering. *Psychological Science, 24*(7).

Wentzel, K.R. (2009). Teacher-Student Relationships. In K.R. Wentzel & D.B. Miele (Eds.) *Handbook of motivation at school*. Routledge. Retrieved from https://books.google.com/books?hl=en&lr=&id=MmyaCwAAQBAJ&oi=fnd&pg=PA211&dq=teaher+student+relationships&ots=Z75IqXskq&sig=AvVNth6hcM89q4EEAYmh3OUPf34#v=onepage&q=teacher%20student%20relationships&f=false

Whelan, R. (2008). Effective analysis of reaction time data. The Psychological Record, 58(3), 9.

Young, K. S., van der Velden, A. M., Craske, M. G., Pallesen, K. J., Fjorback, L., Roepstorff, A., & Parsons, C. E. (2017). The impact of mindfulness-based interventions on brain activity: A systematic review of functional magnetic resonance imaging studies. *Neuroscience & Biobehavioral Reviews*.

Zelazo, P., Carlson, S., & Kesek, A. (2008). The development of executive function in childhood. *Handbook of developmental cognitive neuroscience (2nd ed.)* (pp. 553-574). Cambridge, MA US: MIT Press.

Zenner, C., Herrnleben-Kurz, S., & Walach, H. (2014). Mindfulness-based interventions in schools—a systematic review and meta-analysis. *Frontiers in Psychology*, *5*, 603.

Zoogman, S., Goldberg, S. B., Hoyt, W. T., & Miller, L. (2015). Mindfulness interventions with youth: A meta-analysis. *Mindfulness*, *6*(2), 290-302.