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Mindfulness in education : the impact of mental training on attention and working memory in children

Julia Keller

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**Mindfulness in Education: The Impact of Mental Training
on Attention and Working Memory in Children**

by

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B.A., English, University of Southern Colorado, 1991

M.A., Education, University of Northern Colorado, 1994

THESIS

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ABSTRACT

Mindfulness (MF) is the self-regulation of attention, including sustained attention, switching attention between tasks, and the inhibition of elaborative processing. Another type of attentional skill not specifically targeted in this definition, but that might benefit from MF training, is control over working memory (WM), a type of executive attention: the ability to use attention to maintain or suppress short-term representations of information. Greater WM capacity also means an increased ability to use attention to overcome distraction and is predictive of performance on higher-order cognitive tasks. In this study, I hypothesized that, after eleven weeks of MF training, participants would have improved scores in attention and WM, compared to a control group. Eight elementary classrooms from an urban Title I school in the southwestern United States participated. Four classroom teachers were trained on Mindfulness-Based Stress Reduction and on teaching MF practices in their classrooms. Four teachers were assigned as control classrooms. Pre-, middle- and post-measures were collected from students on attention and WM span. Results tentatively indicate that MF improves attention switching, divided attention, and WM processing.

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The self-regulation of attention is a critical skill for students to master because it allows them to learn efficiently and work well with others. Mindfulness (MF) is one well-established technique for developing one's ability to self-regulate attention. It can be defined as the cognitive ability to pay attention to the present moment without judgment or attachment to a desired outcome. MF training typically involves exercises such as controlled breathing, movement (yoga), and sensorimotor awareness. Studies in the field of health psychology have demonstrated consistent benefits of MF, including reduced pain and stress, improvement in cognitive functioning, and an increase in positive emotion (Tang & Posner, 2009, Davidson et al., 2003, and Majumdar et al., 2002). MF has also been shown to enhance the ability to sustain attention, shift focus from one object to another, and inhibit undesired elaborative processing (Bishop, 2004). The purpose of the proposed research is to investigate whether it is possible to improve attentional self-regulation in elementary school children, using MF training, and thereby improve academic test performance and reduce behavioral problems.

Several studies have demonstrated the impact of MF on specific subsystems of attention in adults. Jha et al. (2007) investigated the effect of MF training on particular aspects of attention, as assessed by the Attention Network Test (Fan et al., 2002). There were three groups of 17 participants: (a) experienced meditators who practiced concentrative meditation at a one-month intensive retreat (the first experimental group), (b) novice meditators receiving instruction on mindfulness-based stress reduction (MBSR; see Kabat-Zinn, 2003) at the University of Pennsylvania (the second experimental group), and (c) novice meditators from the same population, but who had not yet received MBSR training (the control group). The experienced meditators

demonstrated superior conflict monitoring performance compared to the control group and the second experimental group before they received MBSR training. There was a significant difference across groups for RT ($p < .03$) and accuracy ($p < .001$).

Furthermore, the second experimental group demonstrated significantly improved spatial orienting following MBSR training compared to before (approximately 30 ms shorter RT on average at the second time point—after MBSR training—than the first group and the control group combined at the second time point). These results suggest that MF training increases voluntary, top-down attentional skills such as orienting, or the direction and constraint of attention to specific inputs, and conflict-monitoring, or selecting between competing responses.

In a search of 4515 articles in 5 databases, Chiesa et al. (2011) found 23 controlled studies that provided objective measures of cognition following MF training in adults. Ten studies assessed sustained attention, eight assessed selective attention, nine assessed executive attention, and four assessed attention switching. One additional study in another area of attention by Slagter et al. (2007), found that MF increased control over the allocation of limited central processing resources, as evidenced in a reduction of the “attentional blink” deficit. Overall, Chiesa et al. found that beginning phases of MF training aimed at developing focused attention were associated with significant improvements in selective and executive attention. Later stages of MF training, described as an open monitoring of internal and external perceptions, were associated with the improvement of unfocused sustained attention skills. Attention switching is a skill that Chiesa et al. predicted would improve in novice participants after moderately

brief MF training in focused attention. However, no MF study has yet found a significant effect in this type of attention in novice meditators.

Although the positive impact of MF training on older adults is well-established, only a few studies have investigated the impact of MF practice on the development of cognition in children. Flook et al. (2010) examined the effects of a MF awareness program on executive function (EF) in 64 second- and third-grade children. For the experimental group, the program was provided in the students' regular classroom by trainers from the Inner Kids Foundation for 30 minutes twice a week, over the course of 8 weeks. Many of the training sessions were aimed at increasing top-down control of attention (e.g., bringing attention to the breath, monitoring when attention has wandered from the breath, and bringing it back to the breath—the target of attention). Demands on mindfulness were assumed to gradually increase as the exercises that developed the top-down control of attention increased (e.g., sitting meditation and body scan meditation; this increase was intended to increase top-down control) and the more goal-directed and less-reflective exercises decreased (e.g., activities and games that promoted sensory awareness, attention regulation, awareness of others and of the environment). Teachers and parents completed questionnaires (the Behavior Rating Inventory of Executive Function by Gioia et al., 2000, including 86 items on cognition, emotion and behavior rated on a 3-point scale: never, sometimes and often) evaluating students' executive function before and after the MF training. Children who started out with low EF scores showed greater EF improvements than controls (who read silently instead of receiving MF training). Also, experimental students with poor initial EF also showed gains in behavioral control, metacognition, and global executive control following MF training.

There were no overall differences between the group who received MF training and the control group. One criticism of this study is that the improvement in the low EF students might merely reflect regression to the mean. Another criticism is that these findings were based entirely on subjective reports from the teachers and parents. In the abstract, the authors acknowledge that their findings need to be replicated using neurocognitive tasks, behavioral observations, and multiple classroom samples.

In a review of 14 studies since 2005 that directly trained K-12 students in MF (including the Flook et al., 2010 study), Meiklejohn et al. (2012) found a need for more "rigorous scientific evidence of the benefits" of MF practice in schools (p. 2). With the exception of Napoli, Krech and Holley (2005), all of these studies provide only limited evidence due to methodological issues of sample size, design (e.g., non-randomized, no control group), and methods of measurement (e.g., parent ratings, self-reports, interviews). Five of these studies investigated cognition directly or indirectly, but only one (Napoli et al., 2005) used objective measures to investigate the impact of MF on executive control in children..

Napoli et al. (2005)(2005) recruited 254 first, second, and third grade students. Two facilitators, professionally trained MF instructors, met with students during their physical education classes for 45 minutes twice a month for a total of 12 sessions over 24 weeks. The training was designed to help students learn to pay attention to the present moment without judgment, and to find novelty in each experience. Students were randomly assigned to the experimental group, which received bimonthly MF training (N = 114), or to the control group, which instead participated in reading or other quiet activities (N = 114). Before and after the MF training, each child was assessed on three

measures. The first measure was the ADD-H Comprehensive Teacher Rating Scale (ACTeRS; Ullmann, Sleator & Sprague, 1997) which uses a rating form that teachers fill out with 24 items assessing the attention, hyperactivity, social skills and oppositional behavior of each student in their classroom. The second measure was adapted from the Test Anxiety Scale (TAS; Sarason, 1978), which measures debilitating test anxiety. The modified version uses a Likert scale (strongly disagree to strongly agree) instead of true-false questions (as in the original version). The TAS has four subscales: self-evaluation, worry, physiological reactions, and concerns about time constraints. The third measure was the Test of Everyday Attention for Children (TEA-Ch), which has two major subtests measuring sustained attention and selective attention (Manly et al., 2001; see descriptions of the TEA-Ch subtests in the Instruments section below). Difference scores between pre and post-test measures were standardized and submitted for analysis. Paired t-tests showed statistically significant benefits of MF on the TEA-Ch selective attention subscale ($p < .001$, $d = .60$), the ACTeRS Attention Subscale ($p = .001$, $d = .49$), the ACTeRS Social Skills subscale ($p = .001$, $d = .47$), and the Test Anxiety Scale ($p = .007$, $d = .39$). The TEA-Ch sustained attention subscale showed a trend towards improvement from pre- to post-test, but the difference did not reach statistical significance ($p = .350$.) Overall, these findings indicate that there was a decrease in test anxiety (as measured by the TAS), a decrease in negative classroom behaviors (as measured by the ACTeRS), and an increase in the ability to selectively pay attention.

To summarize, many studies have demonstrated benefits of MF practices in adult populations, but very few studies have used objective measures to examine the potential benefits of practicing MF on children's cognitive abilities. Napoli et al. (2005) suggests

the promise of MF training, but needs to be replicated with older and younger children and extended by using other measures of executive control (such as WM). Also, the Napoli study is limited in that they used relatively infrequent MF training (only twice per month), so perhaps they underestimated the potential benefit of MF training. In the present study, MF training was administered on a daily basis by the classroom teacher, which has the potential of being much more practical (no need to hire additional personnel). Furthermore, Napoli et al. did not examine the impact of MF training on important variables such as working memory capacity and academic performance.

The Current Study

The primary purpose of the proposed research was to investigate whether mindfulness practices improve the development of attentional skills and WM span in children. Secondly, we investigated the effect of incorporating MF practice in the classroom on reducing students' negative behavior.

One type of attentional skill, which is extremely important yet was not directly examined in previous MF studies with children (e.g., Napoli et al., 2005), is control over working memory (WM). Engle (2002) defined WM capacity as executive attention – the ability to use attention to maintain short-term representations of (currently) relevant information, while suppressing representations of irrelevant information. Greater WM capacity implies an increased ability to use attention to overcome distraction (Engle, 2002). It is important to study WM capacity because it is predictive of performance on many higher-order cognitive tasks and success in academic and professional settings. Jha et al. (2010) examined the working memory capacity and mood of military personnel as they prepared for active military service in a war zone before and after an MBSR

program, dividing participants into those who practiced meditation frequently versus those who practiced rarely. The study used an operation span task (Ospan) as the measure for WM; Ospan involves remembering letters over brief intervals while solving simple math problems. Results showed that frequent meditators maintained both their working memory (WM) capacity and their positive mood over the course of training, despite the stresses of preparing for combat, whereas the infrequent meditators suffered deterioration in both abilities. Although this study of adult military personnel differs greatly from the context of primary education, and was a correlational rather than an experimental study, it provides a ray of hope that MF practices would improve critical WM capacity skills in school-aged children.

Method

Participants

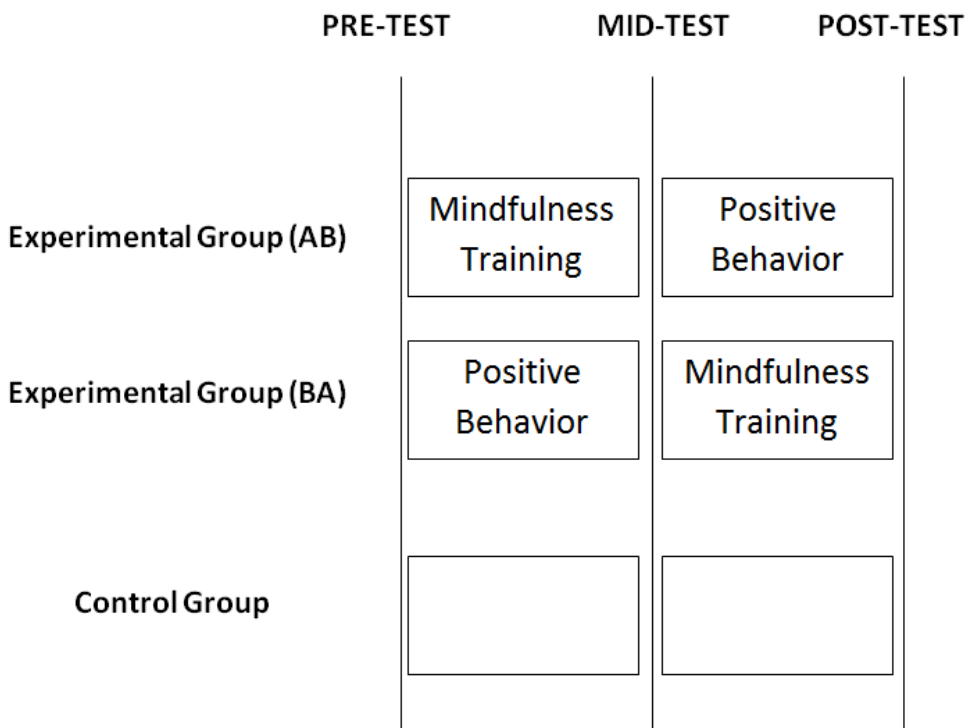
After obtaining approval from the University of New Mexico (UNM) IRB as well as from the school district in question, four experimental teachers from an urban school in the southwest were recruited: a first-grade English-only teacher, a second-grade bilingual teacher, a third-grade English-only teacher, and a fourth-grade English-only teacher. After signing consent forms, the teachers filled out the Kentucky Inventory Mindfulness Scale (KIMS; Baer, 2004) as a baseline measure of their MF abilities. Subsequently, they completed a mindfulness-based stress reduction course (MBSR) and received materials on how to implement MF training in the classroom. They retook the KIMS assessment of MF training at the study mid-point and at the end of the study, to assess changes in their MF abilities.

Four control teachers were also recruited: a second-grade English-only teacher, a

third-grade English-only teacher, a third-grade bilingual teacher, and a fourth-grade English-only teacher. The goal was to match the control and experimental groups as closely as practically possible in terms of age and English ability (See Table 2). The control teachers signed consent forms, but did not take the MBSR course or receive any instruction in MF as part of this study.

A total of 112 students participated in this study—60 experimental students and 52 control students.

Figure 1: Simplified timeline of study events.



Procedure

There were three conditions in the study: C (control), AB and BA. Teachers of the control students did not do anything different from their normal practices for the purposes of this study; they simply taught students the way they usually did. The experimental students participated in either the AB Condition or the BA condition. Teachers in the AB

condition taught mindfulness practices to their students for at least 10 minutes a day for half of the study's duration and taught Positive Behavior Support (PBS) for 10 minutes a day during the second half of the study. Teachers in the BA condition did the opposite: taught PBS for 10 minutes a day in the first part of the study and MF practices for 10 minutes a day in the second half of the study. PBS is a sort of control task that involves no mindfulness, per se, but is often used in public education. It was used by the control group as well, but no data was collected to measure the content or frequency of its use as a behavior control strategy in the classroom. This design is summarized in Figure 1.

The first-grade and third-grade experimental teachers were assigned to the AB condition and the second-grade and fourth-grade teachers to the BA condition.

At the beginning of the semester, in the middle of the year, and at the end of the year, Research Assistants (RAs) blind to the classroom condition (experimental vs. control) administered the Test of Everyday Attention for Children (TEA-Ch) and the Automated Working Memory Assessment (AWMA) to participating students as pre-, mid-, and post-measures of attention and working memory. A total of 112 students completed these measures.

After students were assessed as described above, experimental teachers in the AB condition started teaching MF. MF classes took place in the regular classroom and were part of the daily routine (students were with their familiar classmates). Examples of MF practices are learning how to take deep breaths, recognizing and focusing on thoughts/feelings/physical sensations, eating/smelling/listening/walking mindfully, focusing on moment-to-moment awareness, separating thoughts from emotions and

physical sensations, and developing kind thoughts and behaviors. Teachers in the BA condition taught PBS.

To ensure adherence to the MF/PBS program, teachers in both conditions completed entries in a daily survey. They received a \$5 bonus for each week they completed without missing entries. In this survey, they reported their daily stress level, the MF/PBS lesson they taught that day, and the length of their own MF practice at home. They were also asked to provide comments on the MF/PBS lesson (the comments were coded for themes on challenges and benefits of teaching MF/PBS).

After the end of the school year, data was collected from the school on each student's performance on standardized state and district-level assessments and on each classroom's number of disciplinary referrals during the project. (The standardized assessments are conducted routinely by APS personnel to meet district and state-level goals.) This data will be entered and analyzed at a later point. See Table 1 for a list of dependent measures used in this study.

Table 1. Summary of dependent measures used in this study

Measure	Participants	Time Points		
		Fall	Midpoint	Endpoint
Automated Working Memory Assessment (AWMA)	Students	X	X	X
Test of Everyday Attention for Children (TEA-Ch)	Students	X	X	X
Mindfulness Daily Survey	AB Teachers	*X		
	BA Teachers			**X
Positive Behavior Support (PBS) Survey	AB Teachers			**X
	BA Teachers	*X		
Kentucky Inventory of MF Skills (KIMS)	AB and BA Teachers	X	X	X

Participants: Participants (either students or teachers) who took this measure. Time points: Times the participants took the measure. *Note:*

*=Teachers took this daily survey from October 24, 2011 to January 19, 2012. **=Teachers took this survey from January 30, 2012 to April 20, 2012.

Instruments

The AWMA is a computerized assessment of working memory span designed for

children and young adults from ages 4 to 22. It consists of two memory tests: listening recall and spatial recall. In the listening recall test, students are asked whether a sentence like “apples play football” makes sense. Then they are asked to say the last word of the sentence and remember it for a later memory test. In the spatial recall test, students are shown two shapes, the rightmost of which has a red dot. The computer voice says: “Here are 2 shapes. The shape with the red dot is the same as the shape next to it, even though it is moved around. Now look at these shapes. The shape with the red dot is the opposite of the shape next to it, even though it is moved around. Now you tell me if this shape with the red dot is the same or the opposite of the shape next to it.” Students then receive a score on their storage and processing of information. Engel, de Abreu, Conway and Gathercole (2010) explain the difference between storage and processing:

WM is often assessed by complex span tasks that involve the simultaneous processing and storage of information... [like] the counting span, in which participants are asked to count a particular class of items in successive arrays and to store at the same time the number of target items in each array... These complex span measures stand in contrast to simple span tasks that require only the storage of information with no explicit concurrent processing task (p. 2).

The TEA-Ch assesses the ability of children to selectively attend, sustain their attention, divide their attention between two tasks, and switch attention from one task to another. It was specifically designed for use with children from ages 6 to 16 and was normed with a sample of 293 children in the U.K., ages 6 to 15 years. The short form of the TEA-Ch has four subtests. Below is a description of the four subtests.

Sky Search. This selective attention measure challenges students to scan a visual field filled with various kinds of spaceships. Students are asked to find all the pairs where the two spaceships are the same. The presence of many distractors makes the search a slow and serial process. An item total score is generated by subtracting the age-scaled accuracy score from the age-scaled time-per-target score, based on the number of correct pairs of targets identified and the time it takes to perform the task. The published reliability for this subscale is .75.

Score! This sustained attention measure is a child's version of a well-validated measure of sustained attention. While listening to a sequence of 10 tones, children have to keep a count of the number of "scoring" sounds, as if they were in charge of keeping the score on a computer game. It taxes their ability to self-sustain attention. The published test-retest reliability for this subscale = .76.

Creature Counting. This attentional switching measure has children switch attention frequently between two simple tasks: counting upwards and counting downwards (or backwards; e.g., 5 4 3 2 1). They are asked to count monsters in their caves, with sporadic arrows telling them when they need to change the direction in which they are counting. They are instructed to say "up" when they reach an arrow pointing up (this means count upwards) and "down" when they reach an arrow pointing down (this means counting backwards). The published test-retest reliability for this subscale = .71 for the accuracy score and .57 for the timing score.

Sky-Search DT. In this divided attention measure, students are asked to do a dual task: count spaceships and count sounds. The score is derived by calculating a decrement: subtracting the weighted time per target (time per target or spaceship divided

by the proportion of sounds correctly counted) from the original Sky Search score. The published test-retest reliability for this subscale = .81.

Results

Attention and Working Memory Scores

Overall, 55 boys and 57 girls participated in this study. Ten students with missing scores were deleted from the analysis, leaving a sample size of 102. The scores of three six-year-olds, 16 seven-year-olds, 31 eight-year-olds, 36 nine-year-olds, and 16 ten-year-olds were used in the analysis (51 boys and 51 girls). Outliers, defined as scores two standard deviations above and below the mean on any test at any time period, were removed from the analysis (79 scores out of 2754 total scores or .028% of the scores; outlier scores were removed, not students with outlier scores; the scores of these students were used in other analyses if their scores were not outliers). Three sets of difference scores were calculated: Midpoint (Time 2 – Time 1), Endpoint (Time 3 – Time 2), and Overall (Time 3 – Time 1).

Table 2. Group Descriptions

Teacher	E or C	Condition	Grade Level	Language
1	E	AB	1	English
2	E	AB	3	English
3	E	BA	2	Bilingual
4	E	BA	4	English
5	C	C	2	English
6	C	C	3	English
7	C	C	3	Bilingual
8	C	C	4	English

E or C= Experimental or control teacher. Bilingual means students spoke English for half of the school day and Spanish for the remainder of the school day.

See Table 2 for a description of groups used in this study; see Tables 3 through 5 for group means on the difference scores, and Table 6 for a comparison of group means on

attention switching, divided attention and verbal WM processing—three critical measures in this study.

Table 3. Improvement Scores in DVs between Time 1 and Time 2 (the Midpoint analysis)

Group	G	H	I	L	T	VWM	VWMP	SPWM	SPWMP
1 E	1.91	-1.36	-0.20	1.67	-0.20	0.35	-1.17	2.82	-1.64
2 E	1.79	-1.25	1.00	1.57	0.00	5.65	11.43	3.93	4.99
AVG	1.84	-1.30	0.48	1.61	-0.08	3.32	5.88	3.44	2.08
3 C	1.69	-0.23	-1.25	2.08	2.25	5.15	14.08	9.08	11.39
4 C	2.21	0.92	0.00	2.14	1.57	2.21	4.36	7.21	10.43
5 C	3.45	0.18	0.00	1.64	1.80	16.73	18.09	4.55	6.82
6 C	4.00	-1.27	-0.25	2.50	2.25	11.84	14.17	7.83	6.08
7 C	1.15	0.92	0.15	2.00	0.08	3.68	8.23	7.00	8.31
8 C	2.21	-0.07	2.00	2.36	3.08	8.79	17.21	10.57	13.00
AVG	2.40	0.08	0.16	2.13	1.85	7.73	12.48	7.82	9.51

Group: E=Experimental; C=Control. Measures: G=Focused or selective attention; H=Sustained attention; I=Attention switching accuracy; L=Attention switching speed; T=Divided Attention; VWM=Verbal Working Memory; VWMP=Verbal WM processing/manipulation of information; SPWM=Spatial WM; SPWMP=Spatial WM processing

Table 4. Improvement Scores in DVs between Time 2 and Time 3 (the Endpoint analysis)

Group	G	H	I	L	T	VWM	VWMP	SPWM	SPWMP
1 E AB	1.30	-1.64	-1.00	4.50	-0.40	5.10	2.38	8.00	8.20
2 E AB	0.93	-0.79	1.00	0.64	-0.92	6.94	5.08	0.38	-3.38
3 E BA	0.00	-0.92	1.17	1.31	-0.60	3.25	2.55	-3.58	1.17
4 E BA	0.50	-0.55	1.50	2.67	-0.71	8.79	9.21	-4.08	-5.93
AVG	0.65	-0.96	0.78	2.10	-0.68	6.17	5.09	-0.31	-0.63
5 C	0.44	-1.09	2.00	2.60	0.00	1.55	2.36	4.55	5.27
6 C	0.67	1.00	-0.75	0.00	-1.50	-1.83	-1.75	-3.08	-2.00
7 C	1.33	-0.15	-1.54	0.00	-1.08	0.39	-3.23	-4.69	-5.85
8 C	1.64	0.00	-0.64	1.50	-0.69	7.78	7.69	4.38	-0.24
AVG	1.09	-0.04	-0.32	0.98	-0.87	2.26	1.29	0.18	-0.92

Group: E AB=Experimental group AB; E BA=Experimental group BA; C=Control. CM: Control group mean Measures: G=Focused or selective attention; H=Sustained attention; I=Attention switching accuracy; L=Attention switching speed; T=Divided Attention; VWM=Verbal Working Memory; VWMP=Verbal WM processing/manipulation of information; SPWM=Spatial WM; SPWMP=Spatial WM processing

Table 5. Improvement Scores in DVs between Time 3 and Time 1 (the Overall analysis)

Group	G	H	I	L	T	VWM	VWMP	SPWM	SPWMP
1 E AB	2.45	-2.40	0.20	6.22	0.40	5.45	1.21	1.40	-4.10
2 E AB	2.71	-0.50	2.50	2.21	-1.43	7.95	12.64	1.50	-1.76
3 E BA	1.69	-0.92	0.00	3.85	3.00	12.00	24.00	9.77	15.55
4 E BA	2.71	-2.38	1.50	5.00	0.86	7.62	10.08	3.14	4.50
AVG	2.40	-1.53	1.14	4.10	0.64	8.36	12.42	4.04	4.14
5 C	4.50	-0.91	2.00	4.40	-0.20	18.27	20.45	9.09	12.09
6 C	4.09	-0.92	-1.00	2.50	0.75	11.00	12.42	0.82	4.08
7 C	2.92	0.83	-1.38	3.86	1.62	4.08	5.00	2.31	2.45
8 C	3.86	0.57	1.36	3.86	1.62	16.56	20.93	16.38	14.30
AVG	3.79	-0.06	0.22	3.38	0.37	12.39	14.64	7.33	8.16

Group: E AB=Experimental group AB; E BA=Experimental group BA; C=Control. Measures: G=Focused or selective attention; H=Sustained attention; I=Attention switching accuracy; L=Attention switching speed; T=Divided Attention; VWM=Verbal Working Memory; VWMP=Verbal WM processing/manipulation of information; SPWM=Spatial WM; SPWMP=Spatial WM processing

Table 6. Experimental and Control Group Means for Attention Switching, Divided Attention and Verbal WM Processing at Midpoint, Endpoint and Overall

Group	I	T	VWMPA
Midpoint			
E	0.48	-0.08	5.88
C	0.16	1.85	12.48
Endpoint			
E	0.78	-0.68	5.09
C	-0.32	-0.87	1.29
Overall			
E	1.14	.64	12.42
C	0.22	.37	14.64

Group: E=Experimental. At Midpoint, this only included the AB group. At Endpoint and Overall, this included both the AB and BA groups; C=Control. Measures: I=Attention switching accuracy; T=Divided Attention; VWMP=Verbal WM processing

Forty-two independent sample *t*-tests were conducted on the difference scores. (Note: The Bonferroni correction is usually used to counteract the problem of multiple comparisons and to lower the overall probability of making a Type II error. It was not used in this overall analysis, however, since no significant results were found. The follow-up tests did provide several significant comparisons, as shown in Table 7. If a Bonferroni correction were applied, these results would not have reached significance.)

Table 7. Paired *t*-tests for Difference Measures Between Groups

Measure	Time	Groups	Mean Diff	S.E. Diff	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
Teach I	Endpoint	E and C	1.45	0.89	1.623	.108	0.33
Teach I	Endpoint	2 and 6	3.07	1.37	2.24	.035	0.89
Teach I	Endpoint	3 and 7	2.54	1.29	1.97	.061	0.79
Teach I	Endpoint	4 and 8	2.14	1.24	1.73	.095	0.66
Teach T	Overall	3 and 7	3.83	1.42	2.69	.014	1.12
VWMP	Overall	3 and 7	17.24	6.39	2.7	.013	1.06

Groups: E=BA group; C=AB group and control group. Measure: Teach I=Attention switching; Teach T=Divided attention; VWMP=Verbal WM Processing

A *t*-test comparing the experimental group (the BA group) to a combination of the AB group and the control group on the TEA-Ch attention-switching subtest at Endpoint showed a trend toward significance ($t_{diff} = 1.62, p = .108$). All other *t*-tests comparing experimental and control groups on each test at each time period were non-significant.

Control groups were recruited at the beginning of the study in order to match experimental groups by age or by language. A major finding for developmental researchers studying the development of attention in children is that performance on attentional measures improves with age and that younger children have more limited attentional capacities (Cooley & Morris, 1990). Because there was only one English-speaking first-grade class (the experimental one) at this school, I recruited a second-grade English-speaking class as a comparison group. Because there was only one bilingual class per grade level, I recruited a third-grade bilingual class to compare with the experimental second-grade bilingual class. A third-grade English-speaking class was recruited to compare with a third-grade English-speaking class. A fourth-grade English-speaking class was recruited to compare with a fourth-grade English-speaking class. Another reason to compare individual groups instead of overall experimental and control groups, especially at the Endpoint and Overall, is because Teacher 1 went on emergency leave three weeks before the other experimental teachers stopped teaching MF or PBS. Therefore, substitutes were teaching her class and were not teaching either PBS lessons or reinforcing MF practices. Students were assessed on WM and attention during her emergency leave. For this reason, and because t -tests comparing the experimental and control groups resulted in bilingual classes being compared to English-only classes, and first-graders being compared to fourth graders, all examples of imperfect matching, independent sample t -tests were conducted comparing the groups outlined in Table 2.

There were two significant and one marginally significant results for t -tests comparing Teachers 3 and 7 (the bilingual teachers). The first significant result was on the Overall divided attention test ($t_{diff} = 2.69, p = .014$). The second significant result was

on the Overall Verbal WM processing (or manipulating information) test ($t_{diff} = 2.7, p = .013$). This group's marginally significant result was on the Endpoint attention switching test ($t_{diff} = 1.97, p = .061$). T-tests comparing Teachers 2 and 6 and Teachers 4 and 8 on the Endpoint attention switching test produced one significant result (Teachers 2 and 6; $t_{diff} = 2.24, p = .035$) and one marginally significant (Teachers 4 and 8; $t_{diff} = 1.73, p = .095$). Of interest is that Teachers 3 and 4 were not teaching mindfulness at Midpoint and their group means were *lower* than the control group means at Midpoint [(Teacher 3; $M = -.92$; Teacher 7; $M = .15$), (Teacher 4; $M = .00$; Teacher 8; $M = 2.00$)]. Teacher 2 taught new MF practices only in the first semester and used MF breathing to calm students between transitions on an average of 3 to 4 times a day in the second semester. (See Table 6 for a comparison of experimental and control group means on attention switching, divided attention, and verbal WM processing.)

Table 8. Summary of Closed-Ended Questions

Teacher	Rev MF Fall	Rev MF Sp	Rev. PBS Sp	Fall: GYW	Sp: GYW	Fall: Stress	Spring: Stress	Fall: Practice MF	Spring: Practice MF
1	1-2x/day	1-2x	1x	2.05	1.55	1.18	0.58	Between 5-10"/day and 10-20	10-20
2	4-5	3-4	1-2x	2.63	2.42	2	1.73	10-20	10-20
3	NA	1	0-1x	2.39	2.14	2.08	2.16	5-10	5-10
4	NA	4-5	0x	1.95	2.9	1.73	2.6	Between 10-20 and 20-40	20-40

The MF survey contained these closed-ended questions and weighted answers: Did you teach MF today? (Y/N MF; Yes=1 or No=2.) How many times did you teach or review MF today? (Rev. MF; Not at all=0, Once=1, Twice=2, 3 times=3, 4 times=4, 5 times=5, more than 5 times=6.) In the last 24 hours, how often did you feel things were going your way? (GYW; Never=0, Almost Never=1, Sometimes=2, Fairly Often=3, Very Often=4.) In the last 24 hours, how often did you feel nervous or stressed? (Stress; Never=4, Almost Never=3, Sometimes=2, Fairly Often=1, Very Often=0.) How much time did you spend practicing MF on your own in the last 24 hours? (Practice MF; Not at all=0, 5 to 10 minutes=1, 10 to 20 minutes=2, 20 to 40 minutes=3, more than 40 minutes=4.) Teachers in the BA condition answered an additional question on the MF survey in the Endpoint. How often did you teach or review a PBS lesson today? (Rev. PBS; Not at all=7, Once=6, Twice=5, 3 times=4, 4 times=3, 5 times=2, more than 5 times=1.) This question was asked in the Endpoint to determine if there was any carryover effect from teaching PBS in the fall. Teachers in the BA condition answered the PBS survey in the fall and teachers in the AB condition answered the PBS survey in the Endpoint. The PBS survey also contained questions on well-being (How often did you feel things were going your way?), stress, and practicing MF (answers and weights were identical to the MF survey). In addition, they were asked these questions. Did you teach PBS today? (Y/N PBS; Yes=1, No=2). How many times did you teach or review a PBS lesson today? (Not at all=0, Once=1, Twice=2, 3 times=3, 4 times=4, 5 times=5, more than 5 times=6.) How many times did you teach or review MF today? (Not at all=7, Once=6, Twice=5, 3 times=4, 4 times=3, 5 times=2, more than 5 times=1.) This last question was asked in the Endpoint to determine if there was any carryover effect from teaching MF in the fall.

Surveys: Closed-Ended Responses

Teachers filled out daily surveys for 47 days of the fall experimental period

(October 24th to January 20th) and for 54 days of the Endpoint period (January 30th to April 20th). Teachers in the AB condition answered the MF survey in the fall and teachers in the BA condition answered the MF survey in the Endpoint.

Teacher 1 taught MF lessons 33 times in the fall and 20 PBS lessons in the Endpoint. Teacher 2 taught 35 MF lessons in the fall and 36 PBS lessons in the fall. Teacher 3 taught 43 MF lessons in the spring and 26 PBS lessons in the fall. Teacher 4 taught 44 MF lessons in the spring and 32 PBS lessons in the fall. Average responses on the other questions are summarized in Table 8.

An increase in MF practice may be associated with lower stress levels in teachers and greater well-being, when stress levels are normal. Teacher 1 went on emergency leave in April due to a family crisis. She increased her MF practice in the spring (from between 5-10" per day to 10-20" per day) due to high stress levels, but her well-being (Mean Difference [*MD*] = -.5) and stress levels (*MD* = -.6) decreased in the spring. However, Teacher 4, who also increased her MF practice in the spring (from between 10-20" and 20-40" per day to 20-40" per day), experienced greater levels of well-being (*MD* = .96) and lower levels of stress (*MD* = -.87; higher stress numbers means lower stress levels; see answer weights). But higher levels of MF practice are not, at least in these results, an indicator of greater significance levels on student measures. Teacher 3, whose group produced three of the significant *t*-test results, practiced MF less than the other teachers (5-10 "/day) and only taught or reviewed MF once a day in the spring.

Surveys: Open-Ended Responses

There were three open-ended questions on the surveys. On the MF survey, it was:

"If you taught MF today, describe your lesson in a sentence or two and indicate how long it lasted. If you did not teach MF today, explain why not." On the PBS survey, it was: "If you taught PBS today, describe your lesson in a sentence or two and indicate how long it lasted. If you did not teach PBS today, explain why not." The second question on the MF survey was: "List any new advantages (benefits) or disadvantages (challenges) of teaching MF that you may have discovered today." On the PBS survey it was: "List any new advantages (benefits) or disadvantages (challenges) of teaching PBS that you may have discovered today."

Research Assistants (RAs) participated in the *open coding* of these open-ended questions. This process is described by Merriam (2009):

The process begins with reading... the first document collected in the study. As you read down through the transcript, for example, you jot down notes, comments, observations, and queries in the margins... Because you are being open to anything possible at this point, this form of coding is often called *open coding*... Assigning codes to pieces of data is the way you begin to construct categories. (p. 178-9)

While reading a sample of the open-ended responses, the RAs individually or in pairs took notes on emergent themes (words or phrases that were repeated often by the teachers). They then consolidated these themes into ten themes or less per question. Next, they met as a group to reach consensus on the most common themes for each open-ended question. Finally, using the themes for which they had reached consensus, they individually coded the teachers' answers to the open-ended questions. Pearson

correlations were conducted between pairs of RA ratings to determine if their responses were correlated. Five RAs coded the MF responses; eight out of the ten pairs were correlated at .79 or above (after one outlier was removed from the analysis). The coding of one of the two raters who were correlated at .95 was used in the following summary of results from the MF surveys.

Table 9. Summary of Coding for First MF Open-Ended Question

Teacher	Time	Abs	Assembly	N.T.	B. Breath	Meditate	R.L.	Yoga	Silence
1	1	2	1	0	7	0	1	0	23
2	0	3	0	0	36	2	4	10	0
3	0	5	0	4	6	26	3	0	1
4	0	2	0	1	24	16	9	0	0
Total	1	12	1	5	73	44	17	10	24

Themes: Abs=Absence; N.T.=Not Taught; B. Breath=breathing with the bell; R.L.=reading and listening

First open-ended MF question. For the first open-ended MF question (describe your lesson in a sentence or two and indicate how long it lasted or explain why you didn't teach it), the RAs found these themes for why teachers did not teach a MF lesson that day: Time, Absent (Abs.), Assembly or Not Taught (N.T.). MF lesson themes included these: Breathing with the Bell (B. Breath), Meditate, Reading Listening (R.L), Yoga, and Silence. See Table 9 for a summary of coding for this first MF open-ended question.

Three of the five MF lesson themes (B. Breath, Meditate and Silence) were concerned with what Chiesa et al. (2011) calls the "early phases of MF training" (p. 449) or the development of focused attention. "B. Breath," or breathing with the bell was the most frequently taught MF lesson. All of the teachers began MF instruction with this lesson.

I showed them the bell and called it the "Quite [sic] Bell". I showed them how to breathe. The [sic] are so wild today, I will practice this many times.. (Teacher 1)

I read aloud "Each Breath a Smile". I introduced the bell and how to stop everything and breathe when they hear it. The students [sic] raised their hands when they heard the bell stop and then we all took 3 deep breaths. We did this between each transition. (Teacher 2)

Teached students Introduction to breathe[sic,] how our bodies work to breathe, [sic], guiding students to follow the sound of the bell when they breathe ,[sic]. (Teacher 3)

Students were introduced to how we would use the mindfulness bowl. Also, we practiced simple breathing exercises, we started slow - just taking 3 breaths at at [sic] time (we did this 3 times). (Teacher 4)

All of the teachers initially taught students to focus on their breath. However, Teacher 1 (who had first graders) soon found that this was not effective with her students. *I tried several times. I felt that either I'm not teaching it correctly or they are too young to breath [sic] quietly for a few minutes.* On my advice, she cut MF practice down to a few seconds.

I am taking about 10 seconds several times a day for "Quiet Time". I ring the bell and they close their eyes and stay still--I don't even ask them to breathe deeply anymore. It really does quiet them down! A few of them asked to have 15 seconds!

Two days after this entry, I showed her how to motivate students to practice MF by setting goals with them and by using a CD with children's guided meditations.

J. taught the students a lesson on the "Still, Quiet Place". It was wonderful! I tried it one time after she left, and they made it to 2 minutes. I hope they can make their

goal of 3 minutes for 6 days.

By the last MF session (January 19), these first-graders were able to sit quietly for up to 7 minutes while listening to music or watching a timer projected onto a screen.

The other teachers continued to instruct students to focus on their breath. Teacher 3, who used the word "Meditation" instead of "Breathing with the Bell" or "Quiet Time," references breathing six times during her descriptions of MF lessons. *Continuing to rich [sic] our goal 8 minutes of concentration to stay still/sitting, also bretteing propelly [sic].* It is clear that breathing is part of "Meditation", but it is not clear what "breathing properly" means. Teachers 2 and 4 were more specific about their breathing lessons.

Awareness of length of our in-breath and out breath. (Teacher 2)

We practiced "elevator breaths" with the bell during transitions. (Teacher 2)

Identified the in-breath and out-breath techniques. The students used their fingers under the nose and hands on their stomach. (Teacher 4)

Lesson was focused on counting the number of breaths we take in a short amount of time. Goal was to help the students understand that each child will have different counts.(Teacher 4)

The surveys indicate that Teacher 4 gave more lessons on awareness of the breath than the other teachers did. Other lessons she taught included lessons on reciting poems while breathing, and identifying two types of breathing—*that quick rapid breathing that occurs [sic] when we are angry, upset, or out of breath (maybe from running); also the*

slow, controlled breathing that we experience when we feel relaxed and at peace.

Teachers 2 and 4 also added visualizations for students to concentrate on while breathing.

As we breathed in and out, I told reminded the students to picture themselves as a flower, mountain, water, and space (from our pebble meditation). (Teacher 2)

Teachers 2 and 4 added movement while breathing. Teacher 2 called these movements "Yoga" and Teacher 4 called them "Mindful Movements." Teacher 2 also did one body scan meditation.

The body scan was longer than expected - over 20 minutes. At first the students were into it and after awhile they got bored. If I was to do it again I would lead them through it and not do the guided one. I love how the girl on the CD talked about each body part and what the body part does for the children (example - how your hands help you make a sand castles) and asked them to thank each body part. After the body scan we had a discussion and a couple of the students made a connection such as "I know someone that don't have an arm" and another said "I know someone that don't have a leg". They said they were thankful for their arm and legs.

Teacher 2 also included a lesson on the awareness of how anger feels. *I read the first half of "Ahh's Anger" and talked about how it feels to be angry.* Thus it is clear that the main focus of Teacher 1 was for students to sit quietly for longer periods of time; the focus of Teacher 3 was to sit quietly while "breathing properly" for longer periods of time, and the main emphasis of Teachers 2 and 4 was developing focused attention and body awareness. *After mindful meditation, two students shared that when they are focused on their breathing they do not hear the noise around them (i.e. voices from*

another classroom or kids playing outside). (Teacher 4) There were only a few lessons on developing other types of MF skills—one lesson on using MF to calm negative emotions (Teacher 2), three lessons on developing compassion (Teachers 2 and 4), and one lesson on open-monitoring of internal stimuli (Teacher 4; MF eating).

Table 10. Summary of Coding for Second Open-Ended MF Question

Teacher	Calms	C.rF.	Improve	T.B.	D.	L.o.I.C.	N.E.T.
1	9	5	10	8	6	1	3
2	17	1	8	3	3	3	0
3	6	11	16	0	0	2	3
4	7	6	11	1	4	9	4
Total	39	23	45	12	13	15	10

Themes: C.rF.=Curriculum Refocus; Improve=Student improvement; T.B.=Teacher benefits; D.=Students distracted; L.o.I.C.=Lack of interest child; N.E.T.=Not enough time.

Second open-ended MF question. For the second open-ended MF question (List any new advantages /benefits or disadvantages/challenges of teaching MF that you may have discovered today), the RAs found these themes as benefits: Calms, Curriculum Refocus (C.rF.), Student Improvement (Improve), and Teacher Benefits (T.B.). They found these themes as challenges: Students Distracted (D.), Lack of Interest Child (L.o.I.C.), and Not Enough Time (N.E.T.). See Table 10 for a summary of coding for this second open-ended MF question.

This data indicates that, in the teachers' perception, student improvement (Improve) was the greatest benefit of teaching MF.

Mindfulness works no matter what is exciting the students. I am so glad I taught them this! (Teacher 1)

The students are telling me they are practicing some mindful things we do in class at home. (Teacher 2)

students are more aware [sic] of little [sic] things that are happening at school. specially with behavior and manners that some students are doing. (Teacher 3)

Mindfulness breathing practice can continue to help students get focused without any types of threats or consequences. (Teacher 4)

Teachers also saw that MF practices calmed their students. *I was so amazed at what one of my students said. Another student was very agitated about something and the little girl went up to him and said, "Just calm down and take deep breaths." They really are listening and using it!!! (Teacher 1).* They found this calming effect useful in preparing students for instruction. *Today I was really frustrated with my class because they were not focused. I took a moment to ring the bell and breath [sic] and we moved on with our lesson. The students were much more focused. (Teacher 2)* They also used it to prepare students for tests. *Students are the ones who ask for meditation. we did choose to do it before a test. (Teacher 3)*

Teachers also found that practicing MF with their students and at home to be personally beneficial.

Since I started teaching mindful lessons this week, I don't feel so frustrated throughout the day. I have more energy at the end of the day. (Teacher 2)

I have found that breathing really helps me this year. (Teacher 1)

One of the challenges of teaching MF is that it is sometimes difficult to calm children down or get them to stop talking long enough to focus on being quiet or breathing. *Students need to understand how many times they are interrupting during*

instruction time, just because they want to be talking. (Teacher 3) A second challenge is that some students, especially the older ones, do not like practicing MF. Sometimes this is because the teacher asked them to sing a song about MF and these students thought the songs were "silly." They also appear to be bored or "losing interest" during MF activities.

My student with ODD [Oppositional Defiant Disorder], did well with this in the a.m. but in the p.m. he said this is boring and bang his desk during the bell. The next time in the p.m. he talked throughout it. Overall, he had a better day today though compared to othter [sic] days. (Teacher 2)

When asked why students found MF practice boring, they shrugged their shoulders. This might be a question to ask in future research: What kind of students like or don't like MF practice, and why or why not?

However, MF practice by other students seemed to help *all* of the students.

Students who are resistant [sic] in the beginning of a breathing practice, get quiit [sic] when noticing the peacefulness of the room. (Teacher 4)

PBS Surveys

Positive Behavior Support (PBS) is a behavioral intervention program that is mandated by many school districts around the country. Teachers receive training and support in how to use positive reinforcement to help students learn more appropriate behaviors. Teachers in this study taught PBS instead of MF for at least 10 minutes a day during the fall or spring semester and answered daily PBS surveys. Six RAs coded the

PBS surveys; four of the pairs were correlated between .3 and .5 (a medium correlation) and the remaining 11 were correlated at .5 to 1.0 (strong correlation after 3 outliers were removed from the analysis). The coding of one of the two raters who were correlated at .81 was used in the following summary of results from the PBS surveys (Note: I deleted a repetitive category and changed some of the codes when it was clear that the rater did not understand the teacher's description of a lesson due to teacher misspellings or a lack of knowledge about PBS).

First open-ended PBS question. For the first open-ended PBS question (describe your lesson in a sentence or two and indicate how long it lasted or explain why you didn't teach it), the RAs found these themes for why teachers did not teach a PBS lesson that day: Teacher Absent (T.A.), Time, Holiday (Hol.), Field Trip (F.T.). PBS lesson themes included these: I-ACT (a playground behavior to replace tattling: I Ignore, Ask them to stop, Cruise away, and Tell an adult), Rule Review (R.R.), Behavior Discussion (B.D.), Health/Self Concept (H/SC), Modeling (M), Student Respectfulness (S.R.1), Student Responsibility (S.R.2), and PBS Review (PBS R.). See Table 11 for a summary of coding for this first PBS open-ended question.

Table 11. Summary of Coding for First Open-Ended PBS Question

Teacher	T.A.	Time	Hol.	F.T.	I-ACT	R.R.	B.D.	H/S.C.	M.	SR1	SR2	PBS R
1	4	3	1	0	0	8	6	0	0	0	7	2
2	5	1	0	0	4	5	13	14	1	2	0	6
3	2	4	0	1	0	9	9	1	1	5	11	2
4	1	3	1	1	0	4	4	6	4	4	5	4
Total	12	11	2	2	4	26	32	21	6	11	23	14

Themes: T.A.=Teacher absent; Hol.=Holiday; F.T.=Field trip; I-ACT: a playground behavior to replace tattling: I Ignore, Ask them to stop, Cruise away, and Tell an adult; R.R.=Rule review; B.D.=Behavior discussion; H./S.C.=Health and Self Concept; M.=Modeling; SR1=Student respectfulness; S.R.2=Student responsibility; PBS R.=PBS review.

The words respectful and responsible often appear in PBS lessons. So do the phrases "reviewing the rules" or "proper behavior" or "the correct ways to act." *We went*

over the correct and not correct way to behave. They do know the difference. (Teacher 1)

Goal setting is another common component. *Settin [sic] their goals... to work independent in small groups. (Teacher 3)* Students are taught that they have the ability to choose to behave differently. *Discussed that students are the managers of their behaviors through the "choices" they make. (Teacher 4)* Behavior discussions centered around forming good habits, following directions, and having a positive attitude.

Teachers 1 and 3 focused primarily on reviewing the rules, behavior discussions, and developing student responsibility. While Teachers 2 and 4 reviewed the rules and discussed appropriate behavior, they also had lessons in mental, physical, and emotional health.

Some students came in very angry with each other from recess. I read them the poem "Anger" from the Positive Action book. We talked about what it is, how it feels, recognizing it, and how to calm down. (Teacher 2)

Teacher 2 taught PBS after ten weeks of practicing MF in her classroom. Her PBS lesson on anger included developing an *awareness* of how anger feels. Teacher 4 taught PBS first, and her PBS lesson included a focus on *replacing* anger instead of increasing awareness of it. *Students shared different ways that they can replace their feelings of anger.* After a semester of teaching MF, including compassion practices, Teacher 2 also included PBS lessons on empathy, kind words, and seeing the good in others. This indicates that teaching MF has a carryover effect on how teachers design their lessons in other areas of the curriculum.

Second open-ended PBS question. For the second open-ended MF question (List any new advantages /benefits or disadvantages/challenges of teaching PBS that you may have discovered today), the RAs found these themes as benefits: Attentive Students (A.S.), Teacher Reinforcement (T.R.), Good Behavior (G.B.), Calms, Student Respectfulness (SR1), and Student Responsibility (SR2). They found these themes as challenges: Misbehaving Students (M.S.), Teacher Challenges (T.C.), Distracted Students (D.S.), Time and Stress. See Table 12 for a summary of coding for this second open-ended MF question.

Table 12. Summary of Coding for Second Open-Ended PBS Question

Teacher	A.S.	T.R.	G.B.	Calms	SR1	SR2	M.S.	T.C.	D.S.	Time	Stress
1	1	17	1	1	0	0	0	5	2	1	8
2	3	3	21	0	3	7	1	0	1	1	0
3	14	0	5	0	4	9	1	0	2	1	0
4	6	1	1	0	0	4	3	1	11	8	0
Total	24	21	28	1	7	20	5	6	16	11	8

Themes: A.S.=Attentive students; T.R.=Teacher reinforcement; G.B.=Good behavior; SR1=Student respectfulness; SR2=Student responsibility; M.S.=Misbehaving students; T.C.=Teacher challenges; D.S. Distracted students.

The teachers indicate in their answers that attentive students and good behavior are the greatest benefits of teaching PBS. (Teacher Reinforcement (T.R.) is not really a benefit of teaching PBS, but a necessary part of teaching it.)

It's nice to actually have a lesson about good behavior--they listen better.

(Teacher 1)

Students did not get in trouble on the playground today. (Teacher 2)

Students are working more independent and are eager to learn. (Teacher 3)

Teacher 4 did not indicate that PBS increased her students' good behavior, other than to say that students offered some positive opinions after a lesson on anger. In fact she indicates the opposite. *PBS is not assisting in changing the negative behaviors of those*

students who need it the most. She also writes that some students seem bored or disinterested in the constant reminders regarding acceptable behaviors.

PBS and MF: A Comparison of Results

PBS uses external rewards to motivate a change in behavior. Self-regulation, whether of attention (MF) or of behavior (PBS) is difficult for children, especially those who are more extrinsically motivated and have less self-control. One such child often found MF practice difficult or boring. *He is not a very happy child and is only happy when he gets material things. (Teacher 2)* All of the experimental teachers used PBS techniques (positive reinforcement) to reward their students for practicing MF.

They are very quiet when they know they are getting a prize. Will they ever do it "just because"?(Teacher 1)

The student in my class who has ODD was still making noises during the bell. I have a couple of students who follow him. So I told the class if they are all still and quiet each time we here the bell throughout the week, I will give them a treat on each Friday. I said one student could ruin this for everyone. I said you don't have to participate, but you have to be still and quiet. Everyone was still and quiet after that. (Teacher 2)

meditating for our goal and new goal as a reward. (ice cream party) (Teacher 3)

Student will receive a small treat at the end of the week for participating mindfully :) (Teacher 4)

PBS strategies are based on teaching students appropriate behavior in social contexts. They offer children "positive behaviors" that will replace the negative behaviors.

We discussed being respectful to each other by listening when others are speaking. I said just because you think something, it doesn't [sic] mean you have to blurt it out right then. You may say it in your head or wait your turn and raise your hand if you feel you want to share your thought. I am using the PBS language more throughout the day. For example I may say, "You need to be responsible and hang up your backpack" or "It is not respectful when you blurt out when I am speaking to the class" or "It is not safe when you run in the classroom". (Teacher 2)

In contrast, MF practice often reduces negative behaviors, without specifically targeting them. Teacher 2 found this out while teaching MF. *The students seemed quieter today and didn't blurt as much.* When she wasn't teaching MF, she had to use PBS strategies to reduce student blurting.

Both of the AB teachers (who taught MF the first semester) continued to review MF practices the second semester when they needed to calm their students down.

We took some deep breaths several times today. I told them to hold their breath for a few seconds before exhaling. Then the phone rang and I answered it. When hung up, some kids were still holding their breath! Children. (Teacher 1)

We breathed with the bell and smiled as we breathed out. (Teacher 2)

Teachers seemed to find that PBS and MF were complementary strategies for reducing negative behavior and increasing positive behaviors.

Kentucky Inventory of MF Skills (KIMS)

Teachers took the KIMS at three time points: the summer before school started,

in February, and in April. Teachers answered 41 questions. If a question was about a mindfulness skill (e.g., "I pay attention to how my emotions affect my thoughts and behavior") answers were weighted this way: Never or very rarely true=1, Rarely true=2, Sometimes true=3, Often true=4, Very often or always true=5. If a question indicated a lack of MF (e.g., "I disapprove of myself when I have irrational ideas"), answers were weighted in this way: Never or very rarely true=5, Rarely true=4, Sometimes true=3, Often true=2, Very often or always true=1. See Table 8 for a summary of the average score teachers received at each time point (Teacher 1 did not take the KIMS a third time because she went on emergency leave at the end of the school year.)

Average scores indicate that teaching MF improves scores on the KIMS and that all of the teacher's means were higher at the end of the year than the beginning.

Table 13. Summary of Average Scores for Teachers on the KIMS

Teacher	Summer 2011	February	
		2012	April 2012
1	2.56	2.87	NA
2	3.33	4.13	3.92
3	3.37	3.13	3.54
4	2.89	3.69	3.67

Discussion

One of the aims of this study was to determine whether mindfulness practices improve the development of attentional skills and WM span in children. Teachers learned how to practice MF on their own and how to introduce and reinforce MF practices to their students. Results showed that, overall, there was a trend toward significance on attention switching. Follow-up tests found significant results in attention

switching, divided attention, and verbal WM processing. However, WM processing is mostly irrelevant as it does not provide evidence that WM span has improved. What mechanisms of MF were responsible for the results in attention switching and divided attention?

Holzel et al. (2011) proposes that MF works through four different mechanisms: attention regulation, body awareness, emotion regulation reappraisal and exposure, extinction and reconsolidation, and changes in perspectives on the self. Attention regulation involves sustained attention on a focus of attention (e.g., breath) and returning attention to the object of attention when distracted. In their surveys, all the teachers indicate that they instructed students to focus their attention on their breath, but there is no indication that they taught students to bring their attention back when they got distracted. Body awareness focuses on the physical perceptions of breathing, emotions, or other body sensations. Teachers 2 and 4 included lessons on body awareness; Teachers 1 and 3 did not. Emotion regulation is approaching emotional reactions in a nonjudgmental manner; none of the teachers taught lessons on this. Emotion exposure, extinction and reconsolidation is opening oneself up to whatever is present in the internal and external environment without reacting to it. This is what Chiesa et al. (2011) would call open-monitoring. Teacher 4 included one only lesson on open monitoring; therefore, improvements in students' attention and working memory cannot be attributed to the teaching of open monitoring. This study's lack of significant results found on the sustained attention test is further evidence of Chiesa et al.'s (2011) statement that open monitoring practice is mostly associated with improvements in sustained attention. Change in perspective of self is detachment from an identification with a solid sense of

self and is an abstract concept developed only in adult practitioners at advanced stages of practice.

Thus it appears, in the present study, that student improvement in attention switching and divided attention are due to the development of focused attention according to Chiesa et al. (2011) and to the development of attention regulation and body awareness, according to Holzel et al. (2011).

The significant (or marginally significant) findings in attention switching are particularly interesting in light of what Chiesa et al. (2011) did *not* find in their review of MF literature regarding cognition. This study is the first to indicate that MF practice, specifically the development of focused attention skills, can produce significant results in attention switching in novice meditators.

Another significant benefit of MF training was on divided attention (comparing a matched experimental classroom and a control classroom), a subcategory of attention that is thought of by some psychologists as another form of attention switching, at least when both tasks involve conscious processing. In a discussion of the findings of a study on dual-task performance, Galotti (2008) says that "one hypothesis is that participants alternated their attention between the two tasks..." (p. 138). Another possible explanation is that one of the two tasks could be performed automatically. However, this is unlikely. In the TEA-Ch Divided Attention measure, students had to count sounds and circle spaceships at the same time. Both tasks required conscious awareness and intention. A third possible explanation is that the participants learned how to combine two separate tasks. If this were true, then why was Teacher 3's group difference the only

one that was significantly higher than comparable control groups (and their group mean was at least 1.38 points higher than all of the other groups) when comparing pre- and post-tests (Overall)?

Another key finding was the significant *t*-test on verbal working memory processing. What makes this finding more interesting is that it was produced by the bilingual experimental group, who would have more difficulty manipulating and processing verbal information in their second language, English, and yet managed to overcome this difficulty and surpass their older peers (the third grade bilingual control group). This finding, and other significant and marginally significant *t*-tests by the same bilingual teacher also demonstrate that MF practice translates across cultures as well.

Overall, the teachers found that teaching MF made their students more focused and more aware. Some of the students went home and taught their newly-acquired skills to their parents. Teachers also found it useful to prepare students for instruction and for tests. Teaching MF gave them more energy during the day and helped them deal with personal and professional stressors. They all found it necessary to persuade their students to practice self-regulation by using positive reinforcement. MF practices were challenging to teach because students often prefer to talk instead. Some of the older students, especially those with attention disorders or oppositional defiant disorders, did not like practicing MF (or PBS) but were not able to express their reasons for this preference.

Limitations and Methodological Problems

Lack of random assignment of students. Students were not randomly assigned

to experimental conditions; rather, they were nested within classrooms of teachers who chose whether they wanted to be an experimental or control teacher. As a result, teacher and MF condition are confounded in this study. We can't be sure whether any effect was due to teachers or to MF. Teachers differ in their teaching style and this difference can be important. For example, Teacher 8, a control teacher, considered herself to be a very strict teacher. "Everyone's eyes need to be on the page at the same time," she said frequently. This may be why her students had higher group means than most of the other groups on the WM measures.

There is too much noise in the data. Range, confidence intervals, and standard deviations for the tests seem to indicate measurement error. Ranges for the TEA-Ch were between 14 and 29. Ninety-five percent confidence intervals on the TEA-Ch were between .35 and 1.07. The presence of negative difference scores also suggests measurement error or student boredom and/or lack of motivation. The scores were more variable on the working memory test than the attention test. Standard deviations on the attention test fluctuated between 1.88 and 5.43; standard deviations on the WM test were between 14.88 and 21.28. Ranges on the WM test were between 85 and 112; 95% confidence intervals were between 2.91 and 4.18.

Heterogeneity in MF practices. While MF lessons were generally about the development of focused attention, teachers varied in how they taught students this skill. As Chiesa et al. (2011) points out:

In addition, we have observed a substantial heterogeneity in the types of practices encompassed under the mindfulness “umbrella term” as well as in their

daily and total duration. Taking into account that negative findings were frequently related to the investigation of modified and non-standardized versions of mindfulness training, our results point out the necessity of a more accurate investigation of existing standard mindfulness protocols so as to reduce possible sources of discrepancies across studies (p. 462).

Inconsistency in test administration. This might explain some of the error variance. At Endpoint, the study coordinator observed one of the RAs as she gave the WM test. The RA hesitated in pushing the continue arrow if a student made a mistake. She said later this was because sometimes a student corrected themselves after she (the RA) pushed the arrow key. However, and this is speculation on my part, this small cue was enough for the student to pick up on the fact that he had gotten the answer wrong and he corrected himself when she hesitated.

Training. Tester error could be due to lack of proper training. I was not familiar with either test before the study began. I was not able to observe RAs when they began testing students (for the most part) because I needed to collect permission slips, talk to teachers, answer RA questions, gather testing supplies, and troubleshoot equipment problems. I had to start the training process all over again at the second time point (Midpoint). I had 7 new RAs and 3 experienced RAs who were able to train the new ones while I, once again, was troubleshooting equipment problems, coordinating student pick-up times, answering RA questions, and managing student behavior.

A lack of test standardization. Students were pulled during different times of the day for testing. We tested on Fridays during the second and third round of testing,

and Fridays, especially Friday afternoons, may be the worst time to test students as they are usually tired by then. Testing was also frequently interrupted by fire drills, lock downs, and surprise events (e.g., an announcement that students could come out into the hall to see the Chinese dragon made by the kindergartners). Also, testing more students at one time increased the noise and distraction level in the testing environment.

Boredom and a lack of motivation. Students may have been bored by the tests after the first time and not motivated to perform. The RAs told me that many of the students seem bored and distracted during the second and third rounds of testing.

Future Directions

It is my plan to continue this line of research with the following modifications.

Narrow MF practices to concentration and body awareness practices. In the next study, I want to instruct teachers on how to more precisely focus on attention regulation and body awareness by presenting a day-long workshop for teachers on how to teach MF in their classrooms. An on-site study coordinator, a teacher working at the school site, can provide more consistent feedback and demonstrations of practice to teachers than I could in the present study.

The tests will be supervised by the study coordinator or someone else in the school that has experience in administering standardized tests. I will train this person and any other staff members who will assist with test administration.

Integrate MF practice into curriculum instruction. One of the recommendations of Meiklejohn et al. (2012) is for researchers to provide evidence of a

connection between MF practices and other "desired educational outcomes" such as higher test scores (p. 12).

Simplify the design to a pre and post-test, thus reducing teacher stress and increasing test standardization (by minimizing variability in procedures). Additionally this might eliminate carryover effect suggested in the present study from the teachers who taught MF the first semester.

Concluding Remarks

This work was intended to provide teachers with a research-based intervention that will lower their stress levels and that of their students, making the learning experience more positive and productive. It was also intended to investigate more deeply how the self-regulation of attention (in this case, mindfulness) changes the mental capacities of children (specifically in the area of attention and working memory). Findings in this study tentatively indicate that practices in attention regulation (or focused attention) and body awareness improve attention switching and divided attention in children. Qualitative results show that teachers liked teaching MF and felt that it helped their students learn and helped them reduce their own stress levels. Future studies of greater complexity could remedy some of the limitations in the current study (e.g., lack of a fully randomized sample), increase the sample size, and include other measures of executive function.

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