# Mindfulness in Education: The Intersection of Buddhism and Neuroscience

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*"The faculty of voluntarily bringing back a wandering attention over and over again, is the very root of judgment, character, and will…. An education which should improve this faculty would be the education par excellence" (James, 1890, p.424).*

In essence, William James foresaw in the 1890's what continues to be essential over one hundred years later: the need for mindfulness in the classroom.

Jon Kabat-Zinn brought mindfulness, a centuries old practice of awareness with deep roots in eastern culture, to Western therapeutic practice in the 1970s. He defines mindfulness as "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). The success of mindfulness as a therapeutic practice has been proven effective in over 800 adult studies (Black et al., 2009).

This thesis makes an argument for mindfulness, not as a therapeutic tool, but as a practice that can be taught in elementary classrooms through specific curricula to help students to focus attention, self-regulate behaviors, and calm emotions – crucial factors for achieving academic and social success in school and in life. In creating this argument, I draw on a thriving new body of Western scientific research focused on documenting the benefits of mindfulness on the neurological executive function as well as emotional well-being of adults and adolescents (Greenberg & Harris, 2011; Meiklejohn, et al., 2012).

Effective implementation of mindfulness in schools requires a common definition, model, and agreed-upon goals, along with a clear understanding of the neuroscience

underlying the desired mechanisms of change. Many current papers have linked meditative practices with cognitive outcomes (Zelazo & Lyons, 2012; Davidson & McEwen, 2012, Slagter et al., 2011, Lutz et al., 2008) yet none have established a model that maps the mechanics of mindfulness meditation to executive functions and describes how mindfulness can create long-term changes in students' neurodevelopment.

This paper merges recent writings on Buddhism with current neuroscience research to support mindfulness as an effective intervention to improve both academic and social emotional outcomes for students. The paper begins with a brief discussion of the facets of Buddhist meditation followed by a model, the Buddhist Psychological Model (BPM), which illustrates the construct of mindfulness meditation. The BPM will ground the discussion in a common language to then understand the Western definitions of mindfulness and the history behind the growing interest of mindfulness in schools. Utilizing this model, the paper will then examine current research on executive functions and explore how the research supports mindfulness practices in brain development and more importantly the development of attentional and self-regulatory behaviors. Lastly, the paper will examine current curricula and research studies validating these curricula within K-12 schools.

## Contextual Understanding of Mindfulness

### Buddhist Facets of Mindfulness Meditation

A discussion of mindfulness, even secular-based mindfulness in schools, originates in Buddhist teachings. Yet even within the Buddhist teachings there are differing opinions of the roots of Buddhism (Lutz et al., 2007); hence there is not one single view that can qualify as "the Buddhist view" of mindfulness (Dreyfus, 2011; Fletcher, Schoendorff, & Hayes, 2010). There is general agreement, however, on the two facets of mindfulness

meditation. One is alternately referred to as attention-regulation, focused attention, concentration, or samantha meditation (referred to here as "attention-regulation" meditation). The second type of meditation is frequently referred to as insight oriented, open monitoring or vipassana meditation (Bishop et al., 2004; Grabovac et al., 2011; Lutz et al., 2008). This paper will refer to this type as "insight oriented" meditation. It is important to understand the distinction between these two practices, as discussed below, to fully understand the development of mindfulness. Numerous Buddhists have voiced concern over lifting meditation from its traditional setting, based on Buddhist doctrine and faith, and transplanting it into a secular realm focused on practical results (Bodhi, 2011; Grossman & Van Dam, 2011). Nonetheless, many Buddhist encourage those who are pioneers in this endeavor to introduce secular mindfulness into Western culture and to use the Buddhist teachings to help others develop a greater sense of well-being.

Attention-regulation is the primary initial meditation practice. Learning to focus attention is the basis for all meditation practices. Attention-regulation practice begins with a student focusing on a chosen object (e.g., breath) and returning attention to the object when distracted. This sustained attention on the breath develops the ability to anchor attention in the present moment. By learning to sustain attention and maintain focus in the present moment, a practitioner develops the ability to inhibit distractions in order to stay present with a particular stimulus. As the meditator experiences thoughts, feelings and sensations, they are acknowledged, but not suppressed (Bishop et al., 2004) and the meditator's focus is returned back to the breath.

Attention regulation practice helps raise awareness to the many mental processing habits that detract from learning. These habits of mind include: rumination, concern for

the past or future, anxiety, and excessive pre-occupation with thoughts. These distractions lower the quality of engagement in the present and absorb a student's limited attentional resources (Grabovac et al., 2011, Bishop et al., 2004). The practice of acknowledging and returning to the breath decreases excessive mental processing and allows for the development of responses. An individual can learn to inhibit a dominant response (excessive mental processing) and develop a non-dominant response (returning to the breath). By freeing the mind of habitual thought patterns "consciousness takes on a clarity and freshness that permits more flexible, more objectively informed psychological and behavioral responses" (Brown et al., 2007, p.212). Attention-regulation meditation is thus the cognitive awareness and acceptance of thoughts.

The second form of meditation, insight meditation, is defined as attending to whatever arises in a stream of consciousness, letting oneself be affected by it without reaction and recognizing the nature of emotional and cognitive patterns (Lutz et al., 2008). Insight meditation begins as investigative and curious. Cognitive processing is brought forth to understand the cycle of thoughts and feeling as they arise, to notice the layering of a judgment about that thought or sensation, and then to notice the feeling that is associated with each thought (Bishop et al., 2004). This level of investigative thought and intentional effort allows for a deeper understanding of consciousness and provides a richer and more nuanced experience (Zelazo & Lyons, 2011). The intent of insight meditation is to move from a cognitive level of processing to a non-cognitive experiential process (Grabovac et al., 2011) or a non-conceptual understanding (Dorjee, 2010, Lutz et al., 2008), but this is beyond what is achievable in a classroom setting based on the amount of experience needed to achieve true insight. The eventual goal of insight meditation is to create a long-

term shift in a person's way of being.

## Buddhist Psychological Model

The development of meditative practices, discussed above, is expressed through the Buddhist Psychological Model (BPM, Figure 1) introduced by Grabovac, Lau & Willett, (2011). Figure 1 depicts the complex change mechanisms that are at play in the development of attention regulation. The model illustrates how terminology is used in relation to the two types of meditations and identifies the underlying mechanisms of mindfulness - the thought processes that are presently occurring and the thought processes that need to be brought into awareness and changed (Grabovac et al, 2011). In addressing experience at the level of sensations, thoughts, and emotions; this model can then engender a common conversation about which mechanisms of mindfulness could effectively be used in schools and how research studies should be designed to test these specific mechanisms.

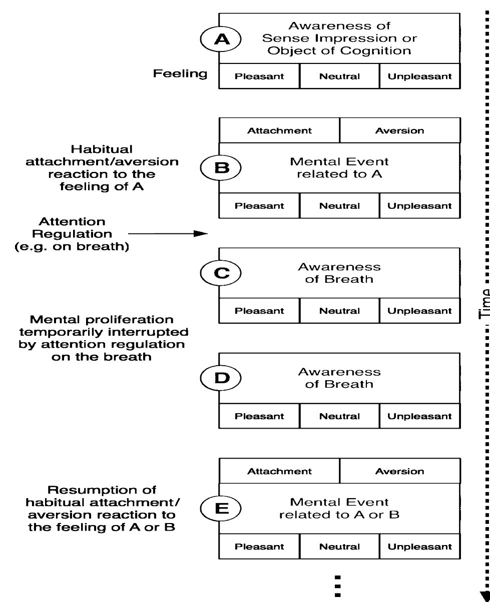


Fig. 1 How attention regulation affects moment-by-moment awareness (Grabovac et al., 2011, p.5).

The overarching goal of mindfulness meditation is for the individual to develop the ability to become aware of internal and external sense impressions and the cascade of thoughts that often follow. An external sense impression is caused by an observed event or external stimulus occurring outside of oneself. An internal sense impression is a thought, remembrance, or other internally driven stimulus that is noted by the person. What frequently occurs after an internal or external sensation is the quick layering of feeling tones, followed by a neutral sense or one of attachment (pleasant feeling) or aversion (unpleasant feeling) (Grabovac, et al., 2011). Our ability to respond to external senses has served as humans' greatest evolutionary advantage by being able to alert to our environment and respond quickly to danger. The quick, habitual response to external senses can also result in narrow and rigid repertoires of responses, resulting in negative affect or suffering. What in the past has been evolutionarily beneficial now takes us away from the present moment toward the "regretted past or the feared future" (Fletcher et al., 2010, p.2). Fletcher and colleagues (2010) further note that we respond to stimuli based on socially defined contextual clues and we are often controlled by these meanings. Through mindfulness practice, a person can begin to recognize the habitual patterns of attachment and aversion to sense impressions and can begin to decouple the associative feelings, eventually leading to a more calm, emotionally regulated and peaceful existence.

In Grabovac et al's (2011) model, the excessive mental processing of thoughts related to the initial sense impression is termed mental proliferation. Mental proliferation is the layering of thought, using scarce attentional resources, and preventing a student from being present; instead, the person is lost in thoughts or ruminations. Attention regulation, by consciously bringing a person's focus back to the breath, disrupts mental

proliferation. Instead of allowing mental activity to continue layering additional thoughts onto a sense impression, the sense impression is cognitively noted, labeled, and then thought is returned to the breath.

The following is an example, using the model, to illustrate how an external or internal sense impression triggers a habitual response, which results in an affective experience for a student. For example, a student notes, "I got an A on the test," the student sees the "A" (sense impression), the student is excited (feeling state), and then has a reaction to that feeling state (attachment). The student's response may be an attachment to the feeling of smartness, an affirmation that that sense impression is correct. But if the student later gets a "C" on a test (sense impression), the associated feeling may be disappointment (feeling state) leading to crumpling up the test (aversion), and a further layering of feelings and thoughts, "I'm not smart, I feel upset, what are other people going to think…." (mental proliferation). The habitual response and mental proliferation can then lead to a negative affect. Hence, being unaware of habitual patterns of attachment and aversion and how they lead to mental proliferation may keep the student unaware of his or her habits of mind and the impact they have on his emotional affect. The goal of mindfulness is to break habitual responses, to let sense events rise and fall without the layering of cognitive processing and to eliminate placing value judgments on these internal or external sense impression.

Learning to regulate attention is important for both attention-regulation and insight meditation practices. In attention-regulation meditation, raising awareness to what is being attended to can momentarily reduce mental proliferation. In insight meditation practice mental proliferation is permanently ceased; initially through a curious

investigative look at the mental proliferation that is occurring then developing non-cognitive processing of sense impressions. Although attention-regulation meditation tends toward a temporary disruption of the mental proliferation, it too can eventually lead toward a more insightful view.

By stopping mental proliferation, a student can think differently about the sense impression. The student can shift his or her thinking from aversive thinking, "I got a C, I am not validated in my view as mathematician, and I don't belong in this class" to a more value neutral response: "I got a C, I wonder what I answered incorrectly and why?" The student can learn to decenter (Teasdale et al., 1995), reappraise (Coffey et al., 2010, p.250), defuse (Fletcher & Hayes, 2005) or reperceive (Shapiro et al., 2006) a situation. Each of these involves the recognition that one's thoughts may not necessarily reflect reality. This awareness allows a person to disengage from habitual thought patterns and perceive the world in a different, and potentially more adaptive way through the process of positive reappraisal, decentering, defusing or reperceiving. By understanding the BPM and the multiple definitions and explanations concerning thought process, the benefit of a mindfulness meditation practice can be better understood.

The on-going practice of mindfulness meditation leads to the development of insights that create a longer lasting shift in a person's sense of well-being. This shift is created by sensations moving from being processed cognitively to being processed experientially. Changing a person's relationship to his or her feelings and those of attachment and aversion eventually leads to the development of equanimity, a balanced state of mind. Equanimity reacts to a sense experience with neither attachment nor aversion. Although it can be attained via attention-regulation meditation, it may be more

difficult to experience consistently. The achievement of constant equanimity is reached through consistent, long-term meditation practice.

In sum, attention-regulation meditation helps students learn to focus attention, bring back their wondering minds and return focus on the breath. This repeated practice breaks the patterns of rumination and distraction and allows students to be fully present and focused on the task at hand, develop the ability to stop mental proliferation and become more aware of their habitual patterns of mind that create negative affect. Through consistent practice and awareness, students begin to be focused, engaged and positive.

**Focus on the Breath**

A final important foundation of the BPM is the breath. The breath, an unconsciously controlled function in our bodies, appears simple, but serves multiple purposes. First, the breath functions as a way of calming the parasympathetic nervous system; important for a student that is experiencing an overwhelming sense of stress. Figure 2 depicts the vagus nerve and its calming influence resulting from slow, deep breaths. Second, the breath, when fully observed, reflects changes that are occurring in a person's emotional state. This important, though subtle, shift in awareness draws attention to experiences that lie just "below the threshold of usual conscious experience and may serve as a powerful tool to refine and broaden one's own thoughts, feelings and other mental states" (Grossman, 2011, p.224). Third, the breath can act, as described above, as an anchor to bring back a wandering mind to the current experience (Bishop et al., 2004; Napoli et al., 2005). Focusing on the breath stops mental proliferation of the thought associated with, for example, the test result. And finally, the breath, in allowing habitual responses to be disrupted, provides more time to form a thoughtful response to a sense impression. It is

important to note that this process of returning to the breath is not about the breathing but constantly about the awareness (Kabat-Zinn, 2011) and the training of the mind in different patterns of thought.

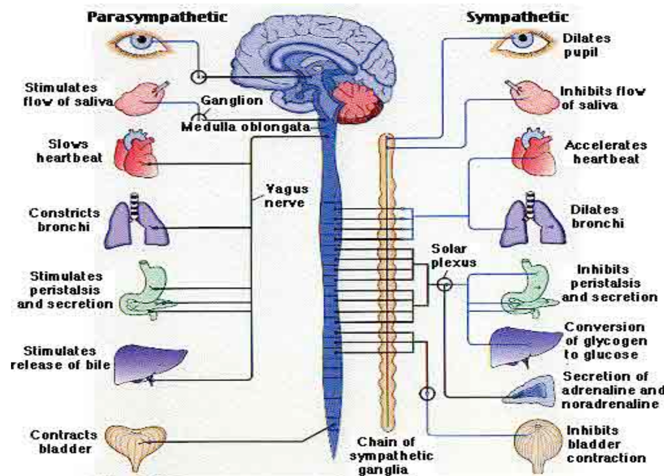


Figure 2 Calming impact of the breath on the vagus nerve.

**Developing Awareness**

In understanding the BPM, we can become aware of habits of mind that prevent students from being present and what needs to be implemented for students to positively experience greater academic and interpersonal growth.

Through the cultivation of a student's awareness and attention, s/he can begin to move along a continuum of awareness, from a mindless "me-self" to a more fully developed "I-self" (Roeser & Peck, 2009, p.119). Utilizing their Basic Levels of Self (BLoS) model, Roeser and Peck (2009), describe the "me-self" as a way of being that relates to the world in a more automatic way based on habits of mind, body and speech that have been developed over time and are acted outside the person's focus of awareness. When a situation cue, or sense impression occurs, a response happens automatically. In contrast, when developing the "I-self," an individual becomes less reactive to sense impressions and

begins to gain insight into his or her habits of mind. Through training, the capacity for shifting and sustaining the focus of attention is developed by becoming more "aware of being aware" (Lutz et al., 2007). This shift in awareness brings a greater amount of forethought, planning, monitoring, and metacognition.

The challenge of mindfulness is to make one aware of the unaware habits of mind. Posner & Rothbart (2007) state that, "Attention serves as a basic set of mechanisms that underlie our awareness of the world and the voluntary regulation of our thought and feelings" (p. 6). They go on to assert that these behaviors are neurologically wired and through repetition these behaviors are further affirmed neurologically to continue to perpetuate response automaticity. Behavioral impulses are ingrained from multiple prior experiences and long-term memory which leads to sensory stimulated reactions, often within milliseconds. These responses are difficult to inhibit because reactions can occur before awareness has been activated.

The BPM illustrates that through enhanced awareness, the breath, and an understanding of how a person can move along a continuum, these habitual reactions can subsist. The practices of mindfulness meditation help develop the time to pause, become aware of a habitual reaction and form a more conscious response creating significant impacts on learning and social interactions.

## Introduction of Mindfulness in Western Culture

### Therapeutic Mindfulness

While mindfulness meditation has existed in Buddhist traditions for thousands of years, mindfulness practices only entered the mainstream of Western culture in the last three decades. In 1979, Jon Kabat-Zinn introduced mindfulness meditation into Western

culture through his Mindfulness Based Stress Reduction (MBSR) therapy, an eight-week course designed to help people respond more effectively to stress, pain, and illness. Kabat-Zinn (1994) defines mindfulness as "paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" (p. 4). MBSR uses both attention-regulation and insight meditations to help participants learn to be present and focused through the use of a variety of mindfulness practices: sitting, body scan (sequentially attending to each part of the body, starting with one's toes and moving to the top of one's head), breath awareness (noticing the sensations in one's nose, throat, and chest as one breathes) and walking meditations (Zelazo & Lyons, 2012). MBSR has been widely implemented and validated as effective through multiple research-based studies. Mindfulness-based therapies in adult populations have been shown to decrease symptoms of stress (Holzel et al., 2010), depression (Shapiro et al., 1998), anxiety (Segal, Williams & Teasdale, 2002), attention deficit hyperactivity disorder (Zylowska et al., 2008) as well as enhance immune functions (Davidson et al., 2003), and to produce changes in the brain structure (Tang et al., 2010).

As mindfulness for adults has proliferated, it has also begun to be used in programs for younger ages. Mindfulness Based Cognitive Therapy (MBCT) developed by Segal, Williams and Teasdale (2002) is structured as 8-weekly sessions where participants learn themed lessons such as operating on automatic pilot, staying present, allowing and letting be, and thoughts are not facts, among other lessons. The effectiveness of MBCT led to the development of Mindfulness Based Cognitive Therapy for Teenagers (MBCT-T) and Mindfulness Based Cognitive Therapy for Children (MBCT-C).

The development of MBCT-C takes the lessons utilized in MBCT and formats them into the world of a child. MBCT-C is a group psychotherapy sessions for children ages 9–13 years old developed specifically to teach “mindfulness techniques with the aim of enhancing self-management of attention, promoting decentering, increasing emotional self-regulation, and developing social-emotional resiliency” (Semple, Lee, Rosa, Miller, 2009, p.220). The guided sessions use a variety of simple sensory exercises to heighten non-judgmental awareness of perceptual experiences (seeing, hearing, tasting, smelling and feeling) and internal events (thoughts, emotions, and feelings). “Asking children to focus their attention on their sensations may lay the foundation for mindful awareness of more complex aspects of their subjective experience, such as emotions or thoughts” (Zelazo & Lyons 2012, p 4). The exercises are incorporated into games, activities, and movement; alternating between focused sensory activities, short breath meditations, mindful body scans and movements. Experiential mindfulness exercises used in MBCT- C are intended to enhance mindfulness by repeatedly focusing attention on internal and external sense events.

**Western Definition of Mindfulness**

Although the concept of mindfulness in Western culture has been made accessible through MBSR and MBCT, the popularity and effectiveness has created a need to develop a common definition of mindfulness (Bishop et al., 2004; Brown et al., 2007; Semple et al., 2009; Burke, 2009; Greenberg & Harris, 2011; Black, Milan, & Sussman, 2009; Lutz et al., 2008). Defining mindfulness in secular terms and identifying outcomes that can be measured has been a topic in several special issues of academic journals (Contemporary Buddhism, 2011; Emotion, 2010, Mindfulness, 2011). Researchers who are developing

tools to measure the effectiveness of mindfulness are also seeking a common definition (Brown & Ryan, 2003; Van Dam et al., 2010; Brown et al., 2011; Baer et al., 2004; Feldman et al., 2006).

This paper uses the definition that was developed by a group of clinical psychologists (Bishop et al., 2004), who defined mindfulness as ‘‘a process of regulating attention in order to bring a quality of non-elaborative awareness to current experience and a quality of relating to one’s experience within an orientation of curiosity, experiential openness, and acceptance’’ (p. 234). This definition incorporates the two aspects of Buddhist meditations that were previously discussed. The first component, self-regulation of attention, involves sustained attention, attention switching, and the “inhibition of elaborative processing” (Bishop et al., 2004, p.233). The initial part of the definition is appealing for use in schools. The second part of Bishop et al’s (2004) definition is associated with developing the capacity to “see relationships between thoughts, feelings and actions and to discern the meanings and causes of experience and behavior” (p. 234). The second part moves the meditation practice from attention-regulation towards the development of insight. The focus of this paper is primarily on the first phrase of the definition.

## Western Empirical Science

A new field of research, the convergence of eastern consciousness disciplines and Western empirical science (Williams & Kabat-Zinn, 2011), is emerging to address issues of attention and self-regulation and their impact on the neurodevelopment of a child. The

convergence of disciplines may provide insight into interventions that can facilitate positive neurological development.

In the previous section the Eastern consciousness discipline of mindfulness meditation and how it has evolved into Western culture was discussed. The BPM was introduced to illustrate how habits of mind and mental proliferation can take away a student's attentional focus. The following section reviews Western scientific research on working memory, inhibitory control, attention leading to the development of self-regulation and discusses how these executive functions link back to the BPM. I will also briefly discuss why these particular executive functions are important for positive academic and social outcomes and how they can be impacted by mindfulness practices. The final section of the paper will review curricula, the key executive functions they support, and research showing how mindfulness practices are currently being implemented in schools to improve cognitive and behavioral outcomes for students.

**Executive Functions**

Executive functions are a multi-dimensional construct that provides higher-order thinking, problem solving, planning, and processing skills. As defined by Diamond (2010), they are "a set of cognitive functions involved in the top-down control of behavior in the service of a goal" (p.782). Executive functions are situated in the prefrontal cortex and have a long, multi-stage developmental process, not fully maturing until a student is in his or her early 20's. While the process depends greatly on biological maturation, Blair (2010) posits that it is also heavily influenced by environmental experiences. Executive functions begin to develop in the first year of life and continue through early childhood (Diamond, 2002). They experience rapid development upon school entry (Riggs et al., 2006), continue

through early adolescence (Rhoades et al.,2009), and reach full development by the early 20's (Zhou et al., 2007). Executive functions play a pivotal role in the school success of students from pre-school through college (Diamond et al., 2007). As stated in Flook et al. (2010), there is a growing body of research supporting the connection between executive functions and self-regulation, in addition to academic and social–emotional achievement (Blair & Razza, 2007; Riggs, Blair, & Greenberg, 2003) from preschool through adulthood (McClelland & Cameron, 2011).

This paper will focus on the maturation and development of three predominantly researched executive functions: working memory, inhibitory control, and the attentional network (Figure 3). These executive functions have been implicated in both social-emotional development and academic achievement, above and beyond IQ (Blair & Razza, 2007; Rhoades, Greenberg & Domitrovich, 2009).

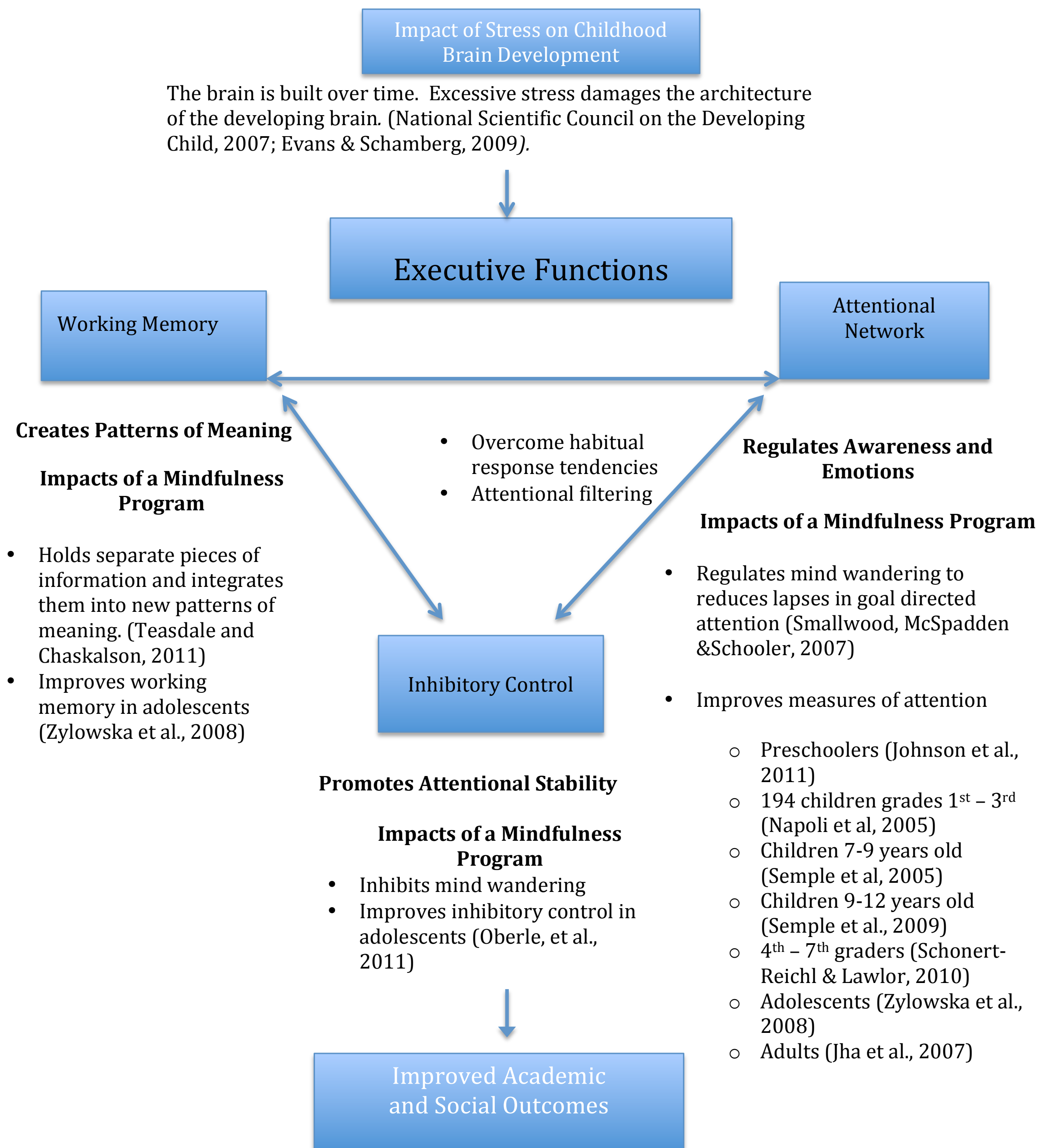


Figure 3. Executive Functions and the Impact of Mindfulness

**Working Memory**

Working memory is a key element of success in school. Students must be able to hold multiple pieces of information in mind; they must combine information from long term memory with novel information and manipulate them in unique ways in order to come up with creative solutions or unique insights. In a recent study, Welsh et al., (2010) revealed that growth in working memory and attention control skills in preschool children was predictive of children's reading and math scores in kindergarten. The authors claim, "early development of working memory and attention control provides an important foundation for domain-specific academic learning" (p. 9). Working memory does not apply solely to the resolution of cognitive problems. Working memory also affects emotional regulation. Teasdale and Chaskalson (2011) affirm that if working memory can hold separate pieces of information and integrate them into new patterns of meaning then negative affect can be transformed.

In relating this view of working memory to the BPM we see first how limited working memory capacity can be consumed by mental proliferation, preventing the inclusion of new information. Second we see how thoughts are combined in habitual patterns which can result in negative affect. Through mindfulness meditation training, these habits of thought come into awareness and begin to be less impactful through the cessation of habitual pattern formation and mental proliferation. Zeidan et al (2010) show significant improvements in working memory after a brief mindfulness training where participants were tasked to maintain focus on the breath and then accurately retrieve information from working memory. A separate study by Jha and colleagues (2009) posited

that practicing mindfulness may serve as a way to cultivate a working memory capacity 'reserve' that could be used in cognitively demanding tasks.

**Inhibitory Control**

Inhibitory control, a second component of executive functions, can have a great impact on learning and social interactions. It is defined as, "the capacity to interrupt a pre-potent, habitual, or reactive response and enact an alternative less salient, subdominant response associated with goal attainment" (Bierman et al., 2008, p.4). Inhibitory control allows a student to regulate behavior and emotion by resisting a strong inclination to do one thing in order to do what is most appropriate or needed. Peers and teachers more favorably view students when the student can inhibit a natural tendency in order to attain goals (Rhoades et al., 2009). For example, resisting using physical aggression (dominant response) and instead using appropriate words (subdominant response). Rhoades et al., (2009) claim that the development of inhibitory control skills may be enhanced by intervention in early childhood. Practicing inhibitory control enhances self-regulation by inhibiting a dominant response and thus creating a delay in a habitual response.

As discussed in the BPM, mindful attention requires self-regulating the focus of attention while inhibiting the urge to elaborate on thoughts and feelings that naturally arise. The student is consciously shifting his focus away from sense impressions and mental proliferation (dominant response) that is inconsistent with the intended goal (focusing on the breath) and returning awareness (non-dominant response) to the goal. This process of shifting awareness from a dominant response to a non-dominant response is practicing inhibitory control, reinforcing attentional skills, and resulting in improved

self-regulation. In a 2011 adolescent study, Oberle et al., (2011) found that "self-reported mindfulness significantly and positively predicted inhibitory control" (p. 15). Oberle and colleagues (2011) support this conclusion by acknowledging the "relationship between mindfulness and inhibitory control is not surprising, given that the ability to self-regulate is at the core of both of these skills" (p.16).

**Attentional Network**

The final component of the executive functions is the attention network. The attention network, which regulates the energy and flow of information, comprises three separate neural attentional networks: the orienting network, the alerting network, and the executive attention network (Brown et al., 2007). The primary function of the attention network is to orchestrate independent, yet interacting, brain networks in order to perform a task or pursue a goal (Posner et al., 2006; Slagter et al., 2011). Although there are three attentional networks discussed in the literature, I will focus my attention on the executive attention network here.

The executive attention network resolves conflicts between neural networks competing for control of consciousness *and* regulates networks involved in thoughts, feelings and emotions (Posner et al., 2006; Brown et al., 2007). In essence, it is the self-regulation of both cognition and emotion (Rueda et al., 2004). According to Bush et al. (2000), "processing of cognitive information enhances activity in the cognitive division and processing of affectively valenced information enhances activity in the affective region" (p. 218). Valenced information is the degree of attachment or aversion that an individual feels toward a specific object or event. However, these two processes are not entirely

independent. During intense emotional states, as observed by Bush et al. (2000), cognitive processes are suppressed.

Existing research relates directly to the BPM by affirming that attention-regulation practice helps develop the neural attentional networks. Adult mindfulness research by Jha, Krompinger, & Baime, (2007), showed that attentional regulation was improved through the use of mindful awareness practices (MAPS). Flook et al., (2010) supported this finding in an adolescent MAPS study showing improvement in students' ability to shift, initiate, and monitor attention as reported by both teachers and parents. An earlier study by Napoli et al., (2005) also reported attentional improvement in early elementary students using a variety of meditation practices. While these studies were self-reports, a recent imaging study validated that "whenever we bring to mind information, whether extracted from sensory input or from memory, we activate the executive attention network" (Posner & Peterson, 1990; Posner, 2012, p.3). In the terms of science, this choice of attentional focus is determined by the functioning of a person's executive attention network.

## Neural Development Affects Behavioral Development

### Effortful Control

Understanding the development of the underlying neural network can then inform our understanding of behaviors linked to these neural networks that are observable and measureable. One of these behaviors is deemed 'effortful control'. Effortful control, as defined by Rothbart and Bates (2006), is "the efficiency of executive attention – including the ability to inhibit a dominant response and/or activate a subdominant response, to plan, and to detect errors" (p. 129). Effortful control has been found to be positively associated

with measures of executive attention (Rothbart et al., 2011; Rueda et al., 2005a). Executive attention provides the basis for students to monitor and resolve conflicts among competing behavioral responses, leading to regulated behavior (planning, decision making, emotional regulation, overcoming habitual responses) through the use of effortful control (Posner & Rothbart, 2007; Brown et al., 2007). Effortful control serves the purpose of both "up-regulating" and "down-regulating" behavior. If a student has a paper that needs to be completed, there is a need to up-regulate his behavior in order to respond to the task at hand. On the other hand, if a student is experiencing an exchange that provokes high negative reactivity, the student requires effortful control to down-regulate his behavior. He must inhibit an emotional and behavioral response that is dominant in order to respond appropriately with a non-dominant behavioral response (Lengua, 2009).

**Effortful Control and Academic Success**

Growing evidence positively correlates gains in effortful control with academic success in school (Valiente et al., 2008; Posner & Rothbart, 2010; Eisenberg et al., 2010; Bierman et al., 2008). A now-classic study by Shoda, Mischel & Peake (1990), testing a child's ability to delay gratification in eating a marshmallow, has inadvertently turned into a longitudinal study. Data gathered over the life-span of participants has implicated effortful control as a predictor for greater sense of self-worth, higher SAT scores, and an improved ability to cope with stress (Mischel et al., 2011).

**Self Regulation**

Strong effortful control underlies the development of self-regulation. Self-regulation is the "ability to modulate behavior according to the cognitive, emotional, and social demands of specific situations" (p.285), essentially the integration of the executive

functions. In a classroom this would show as: children being able to remember instructions (working memory), control their behavior (inhibitory control) and focus attention (attentional network) in order to complete a task (McClelland et al., 2007; McClelland & Cameron, 2011). In addition to the executive function skills, self-regulation also includes the integration of emotional regulation (Buckner et al., 2009; Blair & Razza, 2007; Eisenberg et al., 2010; McClelland & Cameron, 2011). Rothbart et al., (2011) link the above processes by defining self-regulation as the "processes that serve to modulate reactivity, especially processes of executive attention and effortful control" (p.1).

### Self Regulation and Academic Success

As students progress through school, research has found that students who have learned to regulate their thoughts, feelings, behavior and attention are better students, less disruptive in the classroom, hence teachers enjoy them more, creating a positive feedback loop which leads to greater academic gains over the years (Diamond et al., 2007, Blair & Diamond, 2008, Blair & Razza, 2008). In Buckner's (2009) study with youth he showed that children higher in self-regulation were more socially competent, had better academic achievement, and fewer depressive symptoms.

## Detriments to Neural Development and Behaviors

When effortful control and self-regulatory behaviors are not developed, they can have a direct negative impact on social and academic outcomes. Lack of behavioral regulation compounded with a genetically defined difficult temperament and external life stress reinforces neural connections associated with negative outcomes.

### Disregulated Behaviors

Lack of effortful control is a detriment to a student's ability to learn and engage.

Poor effortful control is attributed with two different types of problems: those of externalizing behavior and internalizing behavior (Eisenberg et al., 2010). Externalizing behavior presents as aggressive or anti-social behavior. Externalizing children have difficulty regulating emotion, behavior, and attention. Effortful control plays a role in modulating these difficulties, fostering planning and reducing impulsive behavior (Eisenberg et al., 2010). Internalizing behaviors present as problems with anxiety, rumination, depression and withdrawal and are also correlated with larger amygdala volume (Davidson & McEwen, 2012). These internalizing behaviors are caused by difficulty controlling cognitive and emotional thoughts; i.e., rumination. Developing effortful control is particularly important for children prone to negative emotions.

**Temperament and Reactivity**

Effortful control also refers to temperament, which provides the basis for individual differences in reactivity. Students show up at school with their own unique temperaments, behaviors, emotions, and differences in reactivity. A person high in effortful control tends to have low negative affect (Rothbart et al., 2011). Posner and Rothbart (2007) identified certain reactions as "clusters" of reactions that are found within a child's natural temperament but also influenced by socialization and life experience (p.18). Cluster responses are patterns of behavior that are developed as result of either a single life experience, or repeated life experiences. These experiences can shape the neurological connections between emotions, conceptual understanding of an event, and the use of coping strategies to effectively respond to an event (Posner & Rothbart, 2007).

**Stress**

Stress is an on-going problem among students in today's classrooms and greatly

impacts students' access to their executive functions. Cortisol, a chemical released as a result of stress, causes the amygdala, an evolutionary older part of the brain, to activate a "flight, fight, or freeze" mode of being. Repeated life stress promotes excessive growth of the amygdala (Davidson & McEwen, 2012). The activated amygdala in turn causes limited access to the prefrontal cortex, the neural location of the executive functions. Stress therefore reduces a student's thinking and brain functioning, particularly the executive functions found in the prefrontal cortex (Diamond, 2010).

Chronic, continuous stress, often to the level considered "toxic", has long-term negative implications for brain development (Davidson & McEwen, 2012). Chronically high levels of stress hormones can damage the neural circuitry of the prefrontal cortex and hippocampus areas of the brain. These two areas are important for regulating attention and utilizing short-term, long-term, and working memory (McEwen, 2008). Research shows that stress is greater in low-income home environments (Evans et al., 2011). "In low-resource, unpredictable environments, stress response systems and prefrontal cortex connectivity develop in a way that promotes reactive rather than reflective self-regulation" (Blair, 2010, p. 182). Additional research suggests that the stress of poverty can effect childhood brain development in key areas important for executive functions and stress regulation. A number of studies have also indicated that very high or very low levels of stress reactivity and difficulty with the up or down regulation of stress reactivity are associated with problems with executive function skills, effortful control and self-regulation (Blair, 2010). Stress is not relegated solely to those in low-income environments, stress also impacts students from high socio-economic environments.

A low level of stress is important for the development of self-regulation and early learning in school (Blair & Razza, 2007). In supportive and resource-rich environments, the stress response systems and prefrontal cortex connectivity develop in a way that is conducive to effortful control and self-regulation associated with the developing executive functions. However, in less supportive environments, a need exists to introduce practices to teach students how to modulate stress responses in order to achieve positive impacts on learning similar to those found in more supportive environments.

If a child can begin to recognize his own stress reaction and can stop mental proliferation, illustrated in the BPM, s/he can then exercise a reflective (prefrontal cortex) response rather than a reactive (amygdala) response. A more positive response releases dopamine, producing an approach-oriented and positive emotion, whereas a negative response releases cortisol, causing withdrawal and negative oriented emotions. The approach-oriented emotions help students stay engaged and maintain focused attention on academic requirements and positive social interactions. While anxiety can impair attention and promote emotionally reactive behaviors that interfere with the development of effective academic skills, increased mindfulness is associated with less anxiety and fewer academic problems (Semple et al., 2009).

## Training the Executive Functions

Although the previously discussed behavioral and temperamental barriers can impact students, implementing interventions through focused attention-regulation, a widely believed trainable skill, can develop enhanced attention, self-regulation and emotional regulation (Baer et al., 2004; Baijal et al., 2011; Bishop et al. 2004; Davidson & McEwen, 2012; Lutz et al., 2008, Yang & Posner, 2009; Zelazo & Lyons, 2012). Training has

been recently researched in two different domains: computer training (Posner & Rothbart, 2007) and mindfulness training. I will focus solely on mindfulness meditation training.

**Meditation**

Neuroscientists are studying meditation to better understand the underlying mechanisms and how they correlate with the underlying mechanisms of attention in order to determine best practices for attentional training. Neuroscience research conceptualizes meditation as a "family of complex emotional and attentional regulatory strategies" to cultivate well-being, emotional balance, and attentional capacities (Lutz et al., 2008, p.2). The primary goal of attention-regulation meditation is training attention through practice of mindful meditation skills. The intended result is to produce lasting changes in the structure of the brain and its cognitive functioning as evidenced externally by improved task performance, and internally in the way stimuli are processed and perceived (Slagter et al., 2007, Slagter et al., 2011). Davidson et al., (2003), created the first study to positively show changes in the executive attention network as a result of meditation training (p.569). Meditation training frees up limited brain resources, resulting in improvement in the executive attention network (Slagter, et al., 2007). Mindfulness meditation specifically cultivates process specific learning (Slagter et al., 2011; Lutz et al., 2007) by training students to focus and sustain attention through constantly bringing a wandering mind back from the past or future and into the present moment.

By mapping the effects of mindfulness meditation onto the development of executive functions and self-regulation, one acknowledges the enhancement for students; deep learning, controlled thought, creativity, emotional regulation and healthy social relationships (Roeser & Peck, 2009; Greenberg et al., 2003; Roeser, Peck, Nasir, 2006).

Studies find that meditation training helps develop executive function and self-regulatory skills including monitoring for distraction without interrupting the intended focus (executive attention), disengaging from perceived distractions without further involvement (inhibitory control), and redirecting back to the intended object (Posner & Peterson, 1990, Baijal et al., 2011). Practicing these skills helps develop them as an ongoing trait, creating habits of mind that are more stable and less effortful.

The impact of training on emotions fosters noticing habitual, reflexive responses to stimuli, weakening these negative associations that keep the response habitual, and providing the ability to develop a more positive response. A student's willingness, though mindfulness training, to "look inside" and be self-reflective, helps to develop self-knowledge, leading to self-regulated behaviors (Brown, Ryan & Creswell, 2007, Buckner et al., 2009). When this awareness is blocked or inhibited, a person is less likely to develop effective self-regulation (Deci & Ryan, 2000). Mindfulness is a practice to cultivate a student's consciousness and self-regulated learning (Roeser & Peck, 2009). But only when a student becomes aware of behaviors, thoughts, habits of mind, can then they be modified for optimum social and academic performance. Student's attentional networks are only active when whatever is brought into mind, either sensory inputs or memories, becomes conscious and through this raised consciousness the student is able to develop effective responsible behaviors and responses (Dehaeme et al., 2003, Posner & Rothbart, 2010).

**Mindfulness Curricula for Schools**

Schools are increasingly being seen as a prime environment for implementing mindful programs that promote attention-regulation, emotional regulation, and positive

social behaviors (Diamond & Lee, 2011; Saltzman, 2008; Schonert-Reichl & Lawlor, 2010). These traits can be developed through mindfulness practices and result in research-based improvements in academic achievement. Mindfulness has been identified in reducing aggressive behaviors (Singh et al., 2007; Schonert-Reichl & Lawlor, 2010), reducing ADHD behavior (Zylowska et al., 2008), reducing anxiety and stress (Lee et al., 2008, Semple et al., 2009; Beauchemin et al., 2008; Shapiro et al., 2009), while increasing focused attention (Saltzman & Goldin, 2008; Bogels et al., 2008; Schonert-Reichl & Lawlor, 2010; Napoli, Krechh & Holley, 2005; Jha et al., 2007), emotional-regulation (Saltzman & Goldin, 2008; Broderick & Metz, 2009; Schonert-Reichl & Lawlor, 2010), self-regulation (Roeser & Peck, 2009) and most importantly increasing a students overall sense of well being. Much of this paper has focused solely on the meditation aspect of mindfulness, without acknowledging that all mindfulness programs (DBT, MBSR, MBCT, and school curricula) incorporate discussions and exercises on how to act mindfully in all parts of a participant's life.

Common beliefs among the various curricula developers are:

- Mindfulness helps students become knowledgeable about the internal functioning of their own bodies.
- Mindfulness builds awareness of where they are focusing attention and why this is important to learning.
- Mindfulness helps students begin to be more present in-the-moment and begin to have raised awareness of all sensations.
- Mindfulness not only builds on cognitive skills, mindfulness also enhances social and emotional skills.
- Mindfulness, considered a protective factor, can be trained and fostered.

**Studies Supporting a Mindfulness Curriculum**

Published pilot studies are showing positive outcomes of mindfulness curricula implementation. According to Zelazo & Lyons (2011), "From the perspective of research on the neurodevelopment of self-regulation, mindfulness training has considerable potential as an intervention because it targets both top-down and bottom-up influences on self-regulation" (p. 63). A study by Lisa Flook, Ph.D. and her colleagues (2010) at the Mindfulness Awareness Research Center at UCLA documented children who began their study with poor executive functions and showed gains in behavioral regulation, meta-cognition, and overall global executive control as a result of the school-based Mindful Awareness Practices (MAPS) program, now renamed MindUp. Their results indicate MAPS training benefits children with executive function difficulties. In another recent study, Oberle et al., (2011) investigated the mindfulness training, MindUP, in relation to inhibitory control. Their results showed that mindfulness practice significantly and positively predicts inhibitory control in early adolescence. A secondary result was the finding that morning cortisol (chemical released as a result of stress) significantly and negatively predicated inhibitory control.

**Curriculum Design**

Mindful curricula provide lessons, beyond the act of meditating, to elevate students' awareness. Greater awareness helps students to: eliminate mental proliferation in order to clear working memory, making it available to creatively solve problems; pull different patterns of thoughts into working memory to create positive instead of negative affect; practice inhibiting dominant responses in order to privilege non-dominant responses; and develop executive attention to foster greater emotional regulation and attentional efforts.

To understand how this achieved, the MindUp curriculum will be explained as an example curriculum.

MindUp teaches students how their brains operate, explaining in simple language basic functions of parts of the brain such as the amygdala and the prefrontal cortex. "We're not asking our kids to become neuroscientists," says Hawn, founder of the organization that developed MindUp. "But we want them to understand what's going on in terms of the basics of the brain. In doing so, it gives them a sense of control, that they can form and grow their brains the way they want to. It puts them in the driver's seat" (Gora, 2010, p.16). The knowledge of the brain is interwoven into the curriculum along with a core meditative practice - short listening and breathing exercises to put "students in control of their mental and physical energy" (MindUp, p. 42). The core practice is then integrated into the 15 lessons designed to strengthen a student's sense of well-being. The lessons are broken into four units. The first unit introduces the student to brain physiology, helping him understand what is occurring in the brain when he is stressed or overwhelmed. The student is then introduced to the concept of mindful attention: attending to the here and now, reflecting on thoughts and actions, and making thoughtful choices. The second unit is designed to help students connect their senses (seeing, hearing, touching, smelling, and tasting) with their bodies and their thoughts. Building on the first two units, the third unit helps students begin to see their role in developing healthy mindsets and relationships. The final section moves beyond themselves and leads them to see how their behaviors and attitudes can impact their broader community. The skills taught in this curriculum are learned, over time, and through sustained practice.

**Additional Curricula**

Multiple school-based curricula, with similar lessons, are currently being implemented in schools. See Meiklejohn et al., (2012) for reviews of these curricula:

| Program | Age |
|---|---|
| Inner Kids Program | Pre-K - 8 |
| Inner Resilience Program (IRP) | K-8 |
| Learning to BREATHE | Adolescents |
| Mindful Schools | K-12 |
| MindUp | K-12 |
| Still Quiet Place | Pre-K - 12 |
| Stressed Teens | Ages 13 -18 |
| Wellness Works in Schools | Ages 3 - 18 |

**Impact of Time Spent Practicing**

Additionally, studies have found that the amount of time students spend meditating impacts a variety of outcomes. In separate analyses, average length (in minutes) of sitting meditation practice per week during the mindfulness course predicted greater improvements in state and trait anxiety, perceived stress, and self-esteem (Biegel et al., 2009). The main finding of a study completed by Huppert and Johnson (2010) showed "significant improvement on measures of mindfulness and psychological well-being related to the degree of individual practice undertaken outside the classroom" (p. 270). Napoli et al., (2005) also found that practice of mindfulness training showed statistically significant differences between experiment and control groups in selective attention and reduction of test anxiety.

**Impact of Teacher Experience**

One aspect of variance among curricula is the requirements for teacher training. The effectiveness of curriculum implementation is highly dependent on the familiarity of mindfulness that the teacher holds. Each curriculum supports a differing level of commitment for training. Saltzman, developer of *Still Quiet Place*, clearly believes that "teaching Mindfulness cannot be learned in the weekend seminar model so often embraced in our society" (p. 14) and recommends that a person have multiple years of mindfulness meditation experience prior to teaching mindfulness in a classroom. Whereas Mindful Schools (2011) identifies that training effectiveness will be dependent on the trainer's understanding of mindfulness and requires presenters "participation in and completion of our training to ensure the quality of this curriculum when working with children" (p.2). The MindUp program offers a one-day or two-day training prior to instructor implementation in a school.

**Measuring Mindfulness**

Comprehensive school measurement tools validating construct of mindfulness in a classroom and the associated outcome constructs is of upmost importance. Validated results, based on an agreed definition of the mindfulness construct in relation to education, need to show: improved academic achievement, improved self-regulation and improved emotional-regulation of students. Several measurement tools currently exist, but none are designed specifically to measure the outcomes of mindfulness-based curricula in schools.

The differences in measurements are based on different theoretical underpinnings. Many correlate with each other, but also have a degree of divergence. Aspects of each of the below scales measure important outcomes, but none incorporate the totality of what

needs to be measured for schools. Following are the most widely used scales to measure mindfulness.

The Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003) is a single factor measurement tool measuring the impact of mindfulness training on consciousness (awareness and attention), which facilitates a variety of well-being outcomes. Brown & Ryan (2003), specifically define mindfulness as "the state of being attentive to and aware of what is taking place in the present" (p. 822). Consciousness is restricted by rumination, concern for the past or future, anxiety, and pre-occupation with other thoughts, which in turn affects the quality of engagement in the present. Mindfulness, they claim, helps to disengage individuals from habitual thoughts, beliefs, and behaviors. Mindfulness predicts self-regulated behavior and positive emotional states and was shown to relate to and predict more positive well-being and less cognitive and emotional disturbance in adults (Brown & Ryan, 2003, p. 843). Grossman & Van Dam (2011) believe the developers "have insufficiently addressed distinctions between their own characterizations of mindfulness and general Buddhist definitions" (p.222). They specifically note the narrowness of the focus of the MAAS, which primarily measures attention and awareness, and believe that these are aspects serve as preconditions, rather than equivalents, of mindfulness. This paper asserts that in measuring mindfulness in education both attention and awareness are key factors and are not viewed as preconditions. The wording of the MAAS questionnaire does not specifically address the areas of attention and awareness that would be important for evaluating the impact of a mindfulness curriculum in a classroom.

The MAAS-A (Brown, Loverich, West, & Biegel, 2011) is identical to the MAAS, with the exception of the removal of the question, "I drive places on 'automatic pilot' and then

wonder why I went there" (p.1025). Brown et al., (2011) "showed significant correlation with a variety of indicators of psychological well-being" (p.1027). Again, the remaining questions do not appear to measure mindfulness as offered through school curricula.

Cognitive and Affective Mindfulness Scale-Revised (CAMS-R; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). CAMS-R measures the relationship between higher mindfulness scores and lower experiential avoidance and thought suppression, worry, rumination, and greater emotional intelligence. This model uses a second order factor, mindfulness, and four first-order latent factors: attention, present-focus, awareness and acceptance (Feldman, et al., 2007, p.180). Mindfulness was found to correlate with more cognitive flexibility, problem analysis, mood repair, emotional regulation and well being (p. 185). "Mindfulness can be conceptualized as a response tendency that tends to be stable across situations, yet is modifiable by life experience including mindfulness training" (Feldman et al., 2007, p. 188).

A final mindfulness measurement tool, the Five Facet Mindfulness Questionnaire (FFMQ, Baer et al., 2008) is a five-factor measure: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. The FFMQ was derived from a skills-based model of mindfulness based on Dialectical Behavior Therapy. Baer et al., (2008) used these five facets in order to determine if there were mediating factors between meditation and well-being. In the Buddhist tradition it is widely believed that the "long-term practice of meditation cultivates mindfulness skills and that these skills promote psychological well-being" (Baer et al., 2008, p.331). Baer et al., (2008) showed that the independent value, meditation experience, cultivates several mindfulness skills, which in turn cultivate the independent variable, psychological well-being. A higher

score in the observing facet, attention to both internal and external stimuli, was higher in meditators. Teaching affect labeling, a variable that can be taught outside of meditation but can impact mindfulness, has been shown by recent neuroscience data that "verbal labeling of affect modulates brain responses to emotional stimuli in normal volunteers" (Baer et al., 2008, p.340).

**The nomological network**

Nomological network, representing the mindfulness construct, shows the measurable inputs and the variables affected by the construct. To measure the effectiveness of a school based curriculum, a measurement tool is required that specifically addresses the inputs and outputs as shown in Figure 4.

Two primary variables cause the trait of mindfulness – time spent in being taught a mindfulness curriculum and time spent meditating. As discussed above, learning about mindfulness through a specific curriculum has a direct correlation with improving students' concepts and understanding of how mindfulness applies to their lives. Meditation, a core feature of mindfulness curricula, is a second variable that directly impacts mindfulness effectiveness. Multiple studies listed above have shown the correlation between time spent practicing meditation and increased mindfulness. Included in the nomological network is the impact of brain knowledge on increasing mindfulness. Brain based research is frequently included in curricula, but there is no identified study that parses this feature out of a curriculum and shows the impact. Self-regulation and attention are both identified as being improved as a result of mindfulness based meditation, but a student could have each of these without having meditation experience. Both self-regulation and attention are implicated in improving a student's academic and

social-emotional development (Blair & Razza, 2007). Other adolescent variables that are shown to be affected by the trait of mindfulness are: greater sense of well-being (Huppert & Johnson, 2010), increased academic achievement (Beauchemin et al., 2008; Biegel & Brown, 2010), decreased aggressive behaviors (Schonert-Reichl & Lawlor, 2010), increased attentional focus (Saltzman & Goldin, 2008; Bogels et al., 2008; Schonert-Reichl & Lawlor, 2010; Napoli, Krech & Holley, 2005), greater emotional regulation (Saltzman & Goldin, 2008; Broderick & Metz, 2009; Schonert-Reichl & Lawlor, 2010), and decreased anxiety (Lee et al., 2008; Semple et al., 2009; Beauchemin et al., 2008; Biegel, Brown, Shapiro & Schubert, 2009). Summaries of all adolescent studies, including transcendental meditation and yoga, can be reviewed in: Black et al., (2009), Burke (2009), Greenberg & Harris, (2011). Appendix A lists only those studies related to sitting meditation intervention with youth in school based settings.

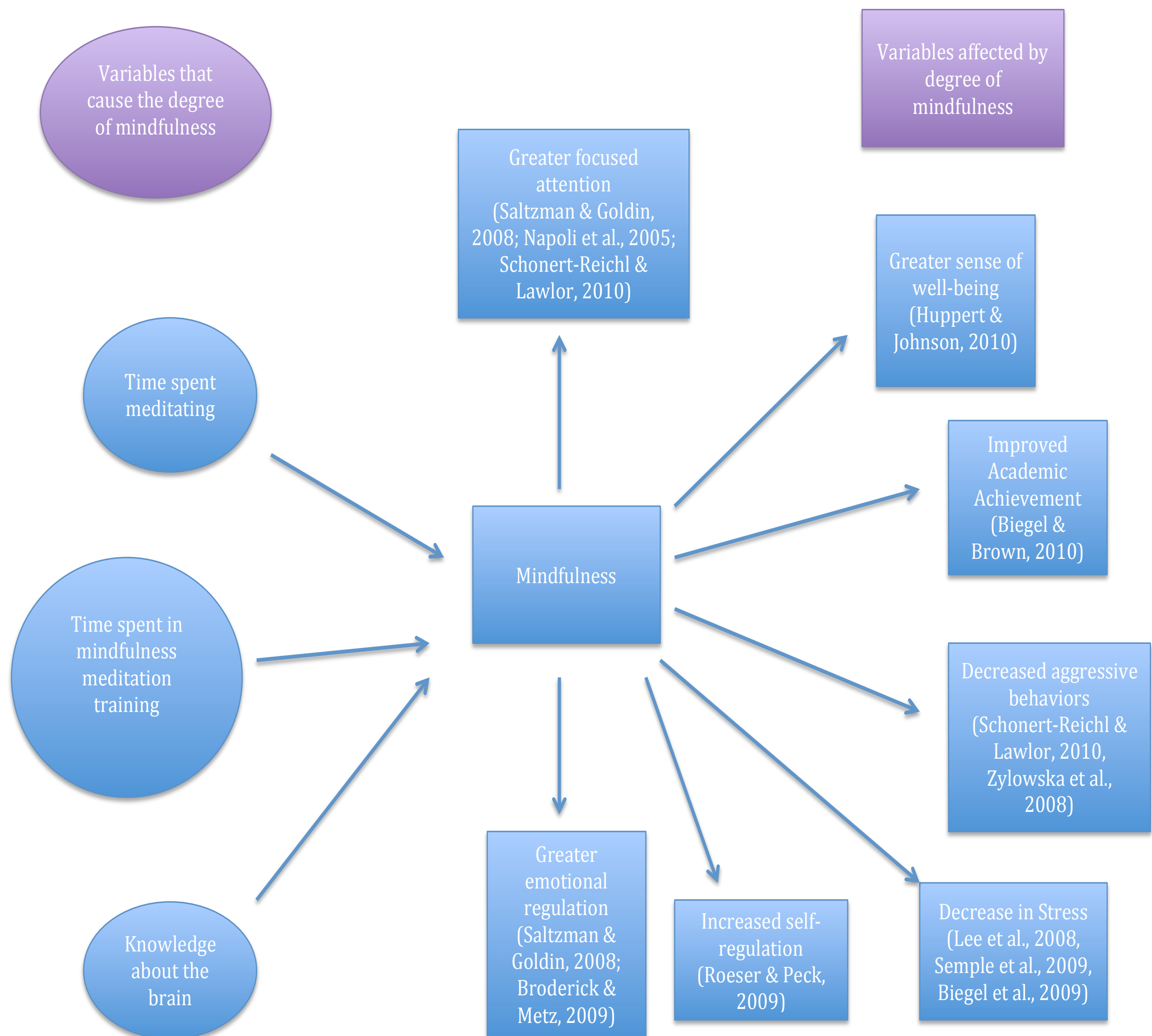


Figure 4. Mindfulness causes and effects in student populations.

## Conclusion

This paper uses the Buddhist Psychological Model to map the mechanics of mindfulness to executive functions and describes how mindfulness can impact the neurodevelopment of students. Attention regulation meditation has been shown to help students learn to focus their attention by continually bringing back a wandering mind through focusing on the breath. This repeated practice, illustrated through the BPM, breaks patterns of rumination and distraction and allows students to gain a greater sense of awareness.

The implications of the practice are shown to improve three noted executive functions: working memory, inhibitory control and executive attention. Working memory is enhanced by both eliminating distractions being held in memory and by changing habitual patterns of thought brought into mind. The mental training of continually monitoring thoughts during meditation is shown to strengthen inhibitory control. Finally, by lessening the impact of affectively valenced information, the efficiency of the executive attention network is improved. The BPM illustrates how attachment and aversion contribute to negative affect and how meditation raises awareness and changes these patterns of mind.

I discuss behavioral patterns that have become neurologically wired through life experiences and genetic temperament and show them to be amenable to mindfulness-based training. Highlighted are the neurological connections between emotions, conceptual understanding of an event, and the use of coping strategies to effectively respond to an event. Training is shown to reduce students' stress, which decreases amygdala-based reactions and facilitates executive function-based responses. Learning, through practice to

preference executive function-based responses effects change in the brain's neural connections.

The interest of mindfulness curricula in schools is growing, yet not without caution. School-based curricula have evolved from MBSR, a highly researched and validated adult stress treatment program, even though most are not intended as therapeutic programs. The goals of the school-based programs are to increase self-regulation, emotional regulation and attention to improve academic and social outcomes for students. While some curricula have been evaluated through small pilot studies, a large empirical study has yet to be published to verify these outcomes. In addition, a common measurement tool for school-based programs is not currently available.

However, the research indicates that a mindfulness program can benefit students' executive functions leading to academic and social achievement. If a mindfulness curriculum is poorly implemented, it may be viewed as merely an ineffective trend. Yet, if well implanted, mindfulness training can lead to a long-awaited shift in the underlying philosophy of our schools. To achieve the greatest success a school should focus on certain factors: the overall goal, the buy-in, and the implementation. The administration should initially determine the goal for implementing a mindfulness curriculum – a curriculum focused on emotional regulation, self-regulation, attention or on compassion and empathy – in order to choose the best curriculum for their school. The successful and effective introduction of a mindfulness curriculum into a school depends on the support of the principal, school counselors, teachers and families, and most importantly, the buy-in of the students. If one of these aspects is missing, the outcomes will vary greatly. The right curriculum is the one that will be most widely embraced by each of these stakeholders.

Time, skills, and resources for training teachers or hiring an outside implementer, all play into this decision. Even with the right curriculum, the skill of the implementer is critical.

*"As a single footstep will not make a path on the earth, so a single thought will not make a pathway in the mind. To make a deep physical path, we walk again and again. To make a deep mental path, we must think over and over the kind of thoughts we wish to dominate our lives." – Henry David Thoreau*

**Appendix A**

| Mindfulness Meditation Studies in Schools | | | |
|---|---|---|---|
| **Study** | **N** | **Participant Description** | **Age/Grade** |
| | | | |
| Barnes et al.,(2004) | 73 | 52% African American Volunteers for a class project | |
| Barnes et al., (2008) | 66 | 100% African Americans with high normal blood pressure | |
| Beauchin et al.,(2008) | 34 | Private residential school, students diagnosed with Learning Disability | 13-18 year old males |
| Broderick & Metz (2009) | 137 | High school senior girls | HS seniors |
| Flook et al., (2010) | 64 | on-campus university elementary school | 2nd/3rd graders |
| Huppert & Johnson (2010) | 155 | 95% caucasion, 5% minority from religious classess in Britian | 14 - 15 year olds |
| Napoli, et al., (2005) | 194 | Student volunteers | 1st, 2nd, 3rd graders |
| Oberle et al., (2011) | 99 | | 4th and 5th graders |
| Schonert-Reichl & Lawlor, (2010) | 246 | | 4th - 7th graders, 9-12 year olds |
| Semple et al.,(2005) | 5 | Teacher referred students wth anxiety symptoms | 7-8 year olds |
| Semple et al., (2009) | 25 | Clinic based remedial reading program | 9-12 year olds |
| Singh et al.,(2007) | 3 | School referred students with conduct disorder | 13-14 year olds |
| Smalley et al., (2010) | 44 | Non-clinical preschool students | 4-5 years old |

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