

The Mindfulness App: The Impact on College Student Mental Health and Well-Being

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By

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Thesis Approval

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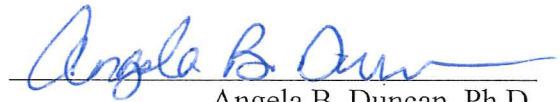
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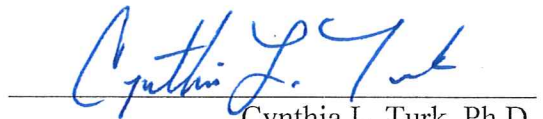
THE MINDFULNESS APP: THE IMPACT ON COLLEGE STUDENT MENTAL
HEALTH AND WELL-BEING

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MASTER OF ARTS DEGREE



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Abstract

There is growing evidence that mindfulness positively impacts health and psychological well-being. Simultaneously, mobile health technologies have expanded the reach and function of health care. Despite increased interest in mobile health applications, studies on the quality and effectiveness of mindfulness-based mobile applications remain scarce. The current study investigated the effects of a five-week intervention using *The Mindfulness App* on the psychological health of college students. Furthermore, the study examined the utility of daily text-message reminders for increasing adherence to study protocol and mindfulness practice. Results indicated use of *The Mindfulness App* resulted in significant increases in mindfulness, $t(58) = -9.21, p < .001, d = 1.43$ and significant decreases in depression, $t(58) = 6.44, p < .001, d = -0.72$; state anxiety, $t(58) = 5.56, p < .001, d = -0.90$; trait anxiety, $t(58) = 6.56, p < .001, d = -0.83$; and inattention and hyperactivity/impulsivity, $t(58) = 7.59, p < .001, d = -0.93$ symptoms over the course of the five-weeks. Furthermore, participants consistently used the app as intended, and reported positive attitudes towards the text-message reminders and the quality of the app. This study provides new evidence that the use of *The Mindfulness App* has the potential to be an effective treatment intervention in improving the psychological health of college students.

Keywords: mindfulness, mindfulness-based mobile app, text-messaging

The Mindfulness App: The Impact on College Student Mental Health and Well-Being

The college years are a critical developmental period in which students formulate habits that lead to success and well-being later in life, and learn to cope with stress and psychological difficulties (Hunt & Eisenberg, 2010). Stress is high among college populations and can trigger underlying vulnerabilities to many psychological disorders (Clark, Beck, & Alford, 1999). As a result, diagnosable mental illnesses and related behaviors are a concern on college campuses (Gallagher, 2006) and have been steadily increasing in prevalence and severity over time (Gallagher, 2013). According to the Association for University and College Counseling Center Directors, 95% of college counseling center directors say the number of students with significant psychological problems has increased on their campus, and 70% believe the number of students with severe psychological problems has increased in the past year (Mistler, Reetz, Krylowicz, & Barr, 2012).

Specifically, rates of anxiety and depression have increased in the last few decades. According to the 2013 National College Health Assessment (NCHA), about one-third of United States college students had difficulty functioning in the last 12 months due to depression, and almost half said they felt overwhelmed by anxiety in the last year. Depression and anxiety are high predictors of risky behaviors, including suicide (Bergen-Cico, Possemato, & Cheon, 2013). Studies have found that more than 30% of students who seek mental health services reported seriously considering suicide at some point in their lives (Novotney, 2014). In addition, it is estimated that 2% to 8% of college students in the United States have Attention-Deficit Hyperactivity Disorder (ADHD). Accumulating research suggests college students with ADHD experience less academic success, greater psychological and emotional difficulties, and are more likely to use alcohol and other drugs at higher rates as compared to their peers (Green & Rabiner,

2012). Furthermore, mental illness among college students has been correlated with lower grades (Struthers, Perry, & Menec, 2000) and decreased social and general problem solving ability (D’Zurilla & Sheedy, 1991).

Mindfulness-based stress reduction (MBSR) is an educational program designed to cultivate greater mind-body awareness that can assist individuals in living a more adaptive life in the face of stress, pain, and mental and physical illness. Mindfulness means paying attention in a particular way: on purpose, in the present moment, and non-judgmentally (Kabat-Zinn, 1994). Mindfulness practice cultivates greater awareness of the unity of the mind and body, as well as the ways unconscious thoughts, feelings, and behaviors can undermine emotional, physical, and spiritual health. Research has demonstrated that increases in mindfulness are significantly related to reductions in anxiety, depression, stress, and medical symptoms (Edenfield & Saeed, 2012). Mindfulness-based treatment manuals, as well as contemporary writings in the Buddhist meditation tradition, further suggest that regular practice of mindfulness cultivates the ability to respond thoughtfully to the activities of daily life by paying attention to the sensory elements of experiences. Examples of common tasks that may foster mindfulness practice include brushing teeth and driving. Practicing mindfulness facilitates improved psychological health and symptom reduction (Baer, Carmody, & Hunsinger, 2012).

Research on the effectiveness of mindfulness in the college population is promising. A meta-analysis examining the effects of mindfulness meditation on stress and anxiety in college students found that 83% ($n = 40$) and 74% ($n = 34$) of studies showed significant reductions in stress and anxiety respectively (Bamber & Schneider, 2015). Vinci et al. (2014) also found that mindfulness intervention in the college population increased state mindfulness and relaxation, and decreased negative affect immediately following the intervention. Mindfulness has also

produced significant improvements across measures of depression, rumination, stress, and mindfulness (McIndoo, File, Preddy, Clark, & Hopko, 2015), and has demonstrated effectiveness in improving eating practices, quality of sleep, and physical health in the college population (Murphy, Mermeistein, Edwards, & Gidycz, 2011). Like standard mindfulness interventions, adapted MBSR has also decreased psychological symptomatology and increased self-control, subjective vitality, and self-reported mindful awareness in college students (Canby, Cameron, Calhoun, & Buchanan, 2014). Results suggest MBSR has a broad range of positive outcomes among college students, and would benefit college stress reduction and mental health promotion programs.

Mindfulness therapy is also effective in reducing inattention and impulsive symptoms, and enhancing self-esteem and self-regulation (Knouse, Cooper-Vince, Sprich, & Safren, 2008). Specifically, studies of mindfulness have demonstrated effectiveness in improving core symptoms of ADHD including attention, executive functioning, and mind-wandering (Mitchell, 2015). Mindfulness meditation engenders neuroplasticity changes in brain areas associated with attention functioning. Studies have demonstrated that overlapping brain regions are implicated in emotional dysregulation in ADHD and mindfulness meditation, and results of neuroimaging studies indicate that changes in the prefrontal cortex, hippocampus, and amygdala are associated with improvements in emotional regulation after mindfulness training (Holzel et al., 2011).

While the benefits of the standardized, full length MBSR curriculum are well documented, the time commitment is substantial. The standard curriculum is conducted in a structured, eight-week group format, during which participants meet weekly for 2 hour 30 minute group sessions in addition to one, daylong retreat. Sessions include practicing three primary mindfulness-based exercises: (a) body scan, (b) sitting meditation, and (c) gentle yoga.

Participants are encouraged to practice these exercises for up to 45 minutes per day, six days per week. Participants are also advised to use recordings for guidance, and to integrate mindfulness into routine daily activities such as driving or eating (Baer et al., 2012). For college students, the full-length MBSR is a significant time constraint and a key reason why many students may fail to engage in these types of programs (Aherne et al., 2016).

Adherence to treatment has been defined as the extent to which a person's behavior (i.e., taking medication, following a diet, and/or executing lifestyle changes) corresponds with agreed recommendations from a healthcare provider (Bosworth, 2010; World Health Organization, 2003). Failure to engage in prescribed or recommended treatment is a significant concern across numerous health conditions. Nonadherence to treatment is estimated between 25% and 40% for acute illness regimens (DiMatteo, 2004), 20% and 60% for chronic illness regimens, and 50% and 80% for preventive regimens (Christensen, 2004). Nonadherence is high in psychotherapy and behavior therapy, with premature dropout rates ranging from 30% to 60% (Wierzbicki & Pekarik, 1993). When treatment regimens are complex and/or require lifestyle changes and the modification of existing habits, nonadherence can be as high as 70%. This indicates that even when appropriate treatment modalities are available and recommended, many individuals do not adhere to them (Martin, Williams, Haskard, & DiMatteo, 2005.)

Furthermore, despite increasing rates of psychological distress, many college students fail to seek the help they need (Blanco et al., 2008; Castillo & Schwartz, 2013). Providers in University medical centers and counseling centers have struggled to determine the best methods to reach students who fail to seek out services or follow recommended treatment protocol (Tjia, Givens, & Shea, 2005). When students fail to receive necessary treatment, the implications are critical. Despite these risks, few studies have investigated ways to encourage students to engage

in and adhere to treatment recommendations (Alschuler, Hoodin, & Byrd, 2008; Herman et al., 2011).

Research has shown that adherence alone prevents disease and improves health outcomes by producing direct biomedical and psychological benefits (Martin et al., 2005), and improving health-related quality of life of patients with disease. In addition, higher rates of adherence correlate with reduced costs associated with acute exacerbation of the disease (e.g., hospital visits). When combined with regular treatment programs, adherence has produced significant improvements in health-promoting behaviors, symptoms management, communication, and disability management (Bosworth, 2010). Despite these known benefits, there are several reasons why nonadherence occurs. Researchers have found that recommended treatment is often misunderstood, carried out incorrectly, or is completely ignored. Other factors that interfere with treatment adherence include: (a) forgetfulness, (b) financial struggles, (c) feeling “too busy”, (d) significant life events (e.g., death), and (e) stress (Martin et al., 2005).

Healthcare professionals should provide evidence-based treatments that are succinct and efficient to increase patient adherence to treatment. Regarding mindfulness, a recent study found improved mental health in college students who participated in brief MBSR (five weeks for 10 hours). Participants demonstrated significant improvements in all composite scores for mindfulness, self-compassion, observational skills, as well as decreased judgment and increased acceptance of one’s internal experiences. Although the brief MBSR produced significant mental health benefits, it did not significantly reduce their levels of trait anxiety, indicating a need for further research (Bergen-Cico et al., 2013). In another study, college students were asked to attend a mindfulness-training program that met for 45 minutes, four times per week, over a two-week period, to investigate whether cognitive abilities might be improved by brief mindfulness

training. Results found improved standardized test scores and higher working memory capacity, indicating that brief MBSR is helpful in improving fundamental cognitive skills (Mrazek & Schooler, 2013). As research suggests, brief MBSR programs benefit individuals who are unable to accommodate the time requirements for the eight-week MBSR, but additional research is needed to assess the minimal amount of daily practice needed to improve mental health as well as the impact of reminders to increase treatment adherence. College students face time constraints as they balance personal, work, and academic life causing mental well-being to be neglected. Although there is a need to make evidence-based mental health interventions brief and convenient without sacrificing effectiveness, there is a paucity of research examining brief mindfulness treatment and potential factors that may improve adherence to treatment among the college population.

Emerging evidence shows that mobile phones can also play an important role in improving adherence to treatment. This is evident by doctors' offices sending automated phone calls or text messages to increase patients' attendance at upcoming appointments (Car, Gurol-Urganci, de Jongh, Vodopivec-Jamsek, & Atun, 2012). The use of mobile phones to promote adherence has grown as ownership rates continue to rise (Thirumurthy & Lester, 2012). Text messaging is useful in collecting and sharing information, and enhancing communication between health personnel and patients in an efficient, low-cost manner (Mukund Bahadur & Murray, 2010). These applications have shown promising results for assisting patients with keeping medical appointments, clinical monitoring and counseling, and chronic disease management (Fjeldsoe, Marshall, & Miller, 2009).

The use of mobile devices by health care professionals has transformed clinical practice. Mobile devices are commonplace in healthcare settings, and mobile applications ("apps") are

now being used as a cost effective and efficient means of improving patient health (Ventola, 2014). Client self-efficacy and the degree to which clients actively engage in treatment has been identified as one of the most significant factors in producing positive therapeutic outcomes (Assay & Lambert, 1999). New infographic released by GO-Globe (2015) indicates that mobile apps are increasing in popularity and usage. Mobile applications now account for more than half (52%) of all time spent on digital media, with smartphone users spending 89% of their mobile media time using mobile apps. The mobile phone is likely to yield greater client engagement as a result of its accessibility, familiarity, and ease of use. In addition, it has the potential to make therapeutic materials and activities less stigmatizing and more convenient and engaging (Matthews, Doherty, Coyle, & Sharry, 2008).

Research has demonstrated mobile app effectiveness in improving functional impairment and self-efficacy in addition to significantly reducing symptoms of stress, anxiety, depression, and overall psychological distress (Harrison et al., 2011). These results support the feasibility of implementing mobile interventions with the potential of improving psychological well-being. Community attitudes toward the appropriation of mobile apps for monitoring and self-management of depression, anxiety, and stress remain positive as long as privacy and security provisions are assured, the program is intuitive and “user-friendly,” and the feedback is clear (Proudfoot et al., 2010).

Although the rapid growth of mobile apps provides the opportunity to increase access to evidence-based mental health care and demonstrates effectiveness as a complementary tool in many psychotherapies (Miller, 2012), the majority of mindfulness apps that are currently available lack scientific evidence about their efficacy (Donker et al., 2013). Furthermore, a systematic review by Doyle, Lennox, and Bell (2013) has highlighted the positive association

between self-reported patient satisfaction and clinical outcomes. Research has demonstrated that despite the increased interest in therapies delivered via technology, studies on user satisfaction and the effectiveness of mindfulness-based mobile applications are scarce. To date, there is little information on the perceived impact of these apps on mindfulness training or health indicators, meaning the potential of mindfulness mobile applications has remained largely unstudied (Plaza, Demarzo, Herrera-Mercadal, & Garcia-Campayo, 2013).

Practicing mindfulness is a core component of treatment. Participants engaging in mindfulness treatment should expect to practice 6 to 7 hours per week as an ideal (Germer, Siegel, & Fulton, 2013). Given the unique demands placed on college students, this amount of time may not be feasible. However, friendly reminders to practice as much as possible may be a way to increase adherence and improve mental health. Relatedly, it is important to expediently assess the amount of mindfulness practice to avoid memory decay. Ecological momentary assessment (EMA) involves collection of real-time data in the clients' real-world environment. EMA typically involves numerous assessments over time, providing intensive longitudinal data. These assessments focus on specific moments, but the investigator may conceptualize the data collectively as samples of the subject's experience. The collection of assessments over time also allows investigators to trace the trajectory of experience over time and context (Shiffman, 2014).

A majority of psychological research uses college undergraduates as participants. However, factors influencing participation in as well as adherence to these studies is limited. In order to inform the design of this study, we conducted focus groups with undergraduate college students ($N = 26$) enrolled in introductory psychology courses. Two themes emerged including stress and adherence. Participants identified the major sources of stress for college students as academics (35%), transition to college (26%), finances (12%), social relationships, (9%), work

(9%), and procrastination (9%). Despite the known benefits of mindfulness meditation in reducing stress in college students, only 5% of participants endorsed engaging in these types of practices. Due to the aforementioned stressors, participants indicated adherence and retention rates are likely to be low in interventions requiring daily participation (i.e., daily practice and time logs) from college students. Therefore, the majority of participants identified text-message reminders as the ideal method of communication to improve adherence. Furthermore, participants reported they would prefer to receive two text messages per day – morning (9:00 a.m.) and evening (9:00 p.m.). To improve adherence to the current study, an automatic text-messaging system was employed.

This study intended to test the effectiveness of a mindfulness mobile app for improving mental health by assessing changes in mindfulness, depression, anxiety, inattention, and impulsivity/hyperactivity symptoms. Thus, researchers hypothesized that participation in a brief, five-week intervention would improve students' mental health through significant increases in mindfulness, and reductions in depression, anxiety, inattention, and impulsivity/hyperactivity at the five-week follow-up. Researchers also examined perceptions of daily text-message reminders for increasing data submission adherence and treatment adherence, and hypothesized that text-message reminders will increase data submission adherence and mindfulness practice. Finally, the researchers assessed college students' perceptions of the mindfulness smartphone application. Researchers hypothesized that participants will report positive attitudes towards *The Mindfulness App* regarding engagement, functionality, aesthetics, information quality, and content.

Method

Participants

Participants were recruited from a mid-sized Midwestern University during Spring and Fall semesters of the academic year. Participants were recruited using several recruitment strategies. Flyers providing information about the study were placed around the psychology building and information about the study was posted in an online sign-up system. Additionally, faculty members made announcements about the study to students enrolled in undergraduate psychology courses. Students enrolled in introductory psychology courses were offered 50 research points for their participation. Other psychology courses were given course credit at instructor discretion. All students were entered into a gift card drawing. Institutional review board approval was obtained prior to the start of the study.

A total of 63 students, 13 in the Spring semester and 50 in the Fall semester, consented to participate in the study. During the study period, 1 (8.3%) and 3 (6%) students in the Spring and Fall semesters, respectively, withdrew from the study. Therefore, 59 (Spring $n = 12$; Fall $n = 47$) of the 63 participants (94%) were included in the analyses.

The majority of the participants were female (74.6%) and 25.4% were male. Participants were between the ages of 18 and 40 years ($M = 19.92$, $SD = 3.87$) and included 59.3% freshmen, 25.4% sophomores, 11.9% juniors, and 3.4% seniors. Self-reported ethnicity consisted of 88.1% Caucasian, 6.8% Hispanic/Latino, 3.4% African American/ Black, and 1.7% Asian/ Pacific Islander. Sixteen participants (27%) reported having a current mental illness and 23.7% of these participants reported taking prescribed psychiatric medications. Participants reported a wide range of diagnoses including anxiety (6.8%), depression (3.4%), attention-deficit/hyperactivity disorder (ADHD; 5.1%), comorbid depression and anxiety (10.2%), and comorbid depression,

anxiety, and ADHD (1.7%). Distributions of gender, student status, ethnicity, and mental health status are shown in Table 1.

Measures

Five-Facet Mindfulness Questionnaire. The Five-Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) is a 39-item measure used to analyze individual's day-to-day mindfulness. The FFMQ uses a 5-point Likert scale (1 = *never* and 5 = *always*) to determine the frequency with which elements of mindfulness occur. Possible scores range from 39 to 195, with overall higher scores reflecting higher levels of mindfulness. This scale was derived from a factor analysis of five psychometrically sound mindfulness subscales: (a) Observing Inner Experience, (b) Describing Experience, (c) Acting With Awareness, (d) Non-Judging of Experience, and (e) Non-Reactivity to Inner Experience. Studies using college student samples further confirmed the factor structure and predictive ability of the measure (Duan & Li, 2016; Gu et al., 2016). The FFMQ indicated adequate internal consistency for subscales (observing, $\alpha = 0.75$; describing, $\alpha = 0.89$, acting with awareness, $\alpha = 0.88$; nonjudging, $\alpha = 0.91$; nonreacting, $\alpha = 0.77$) and adequate internal consistency for the overall scale ($\alpha = 0.77$) (Park, Reilly-Spong, & Gross, 2013). The FFMQ also demonstrated construct validity with correlations ranging from .75 to .89 (Baer et al., 2006; Gill & Hodgkinson, 2007; see Appendix B).

State-Trait Anxiety Inventory. The State-Trait Anxiety Inventory (STAI; Spielberger, 1983a) assesses the presence and severity of current symptoms of anxiety and generalized propensity to be anxious. This measure was normed on different groups including high school students, college students, military recruits, and psychiatric patients (Barnes, Harp, & Jung, 2002). The STAI has 40 items, 20-items for each of the STAI State and STAI Trait subscales.

State anxiety assesses how the individual completing the survey feels at the present moment, and trait anxiety assesses the individual's general level of stress (Julian, 2011; Spielberger, 1983b). Each item is rated on a 4-point Likert scale ranging from *not at all* to *very much so* for the STAI State scale, and from *almost never* to *almost always* for the STAI Trait Scale. Item scores are added to obtain subtest scores, and scoring is reversed for anxiety-absent items (Julian, 2011). The STAI yields a single summary score ranging from 20 to 80, with higher scores indicating greater anxiety levels. This measure has demonstrated excellent internal consistency ($\alpha > 0.89$). In addition, the STAI Trait scale evidenced excellent test-retest reliability ($r = .88$), while the STAI State scale evidenced good test-retest reliability (average $r = .70$) (Barnes et al., 2002; Spielberger, 1983b). This measure has also demonstrated adequate convergent validity with correlations between the STAI Trait scale and the TMAS ranging from .79 to .83, and correlations with Cattell's IPAT scale ranging from .75 to .77 (Spielberger, Gorsuch, & Lushene, 1970). In addition, the Beck Anxiety Inventory (BAI) demonstrated adequate convergent validity with the STAI State scale ($r = .64$) and the STAI Trait scale ($r = .68$) (Kennedy, Schwab, Morris, & Beldia, 2001).

Center for Epidemiologic Studies Depression Scale Revised. The Center for Epidemiologic Studies Depression Scale Revised (CESD-R; Eaton, Muntaner, Ybarra, Smith, & Tien, 2004) is a screening measure for depression and other depressive disorders as defined by the *Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition* (DSM-5; American Psychiatric Association [APA], 2013). The 20 items of the CESD-R measure symptoms of depression in nine different groups: (a) sadness, (b) loss of interest, (c) appetite, (d) sleep, (e) thinking/ concentration, (f) guilt, (g) tired, (h) movement, and (i) suicidal ideation. The total score is calculated as a sum of responses to all 20 questions. The range of possible scores is

between 0 and 60, with scores above 16 indicating a high risk of a depressive disorder and impaired functioning (Eaton et al., 2004). The CESD-R exhibited good psychometric properties, including strong factor loadings and high internal consistency ($\alpha = 0.92$) (Eaton et al., 2004). Convergent validity has also been demonstrated with correlations with the original Center for Epidemiologic Studies Depression Scale (CESD; Radloff, 1977) ranging from $r = .89$ to $r = .93$ (Eaton et al., 2004; Van Dam & Earleywine, 2011). The psychometric properties of the CESD-R have been confirmed across community and college student samples (Van Dam & Earleywine, 2011; see Appendix C).

Adult ADHD Self-Report Scale. The Adult ADHD Self-Report Scale (ASRS; Kessler et al., 2005) is an 18-item scale based on the DSM-5 (APA, 2013) criteria for ADHD. Studies indicate the ASRS is a reliable approach for gathering information about current symptoms of ADHD in college and university students (Gray, Woltering, Mawjee, & Tannock, 2014). Participants are asked to evaluate and rate the intensity of usual symptoms of inattention and hyperactivity/impulsivity. The scale is scored by summing the number of symptoms endorsed at a certain level of severity. Differing by items, responses of *sometimes*, *often*, or *very often* qualifies as clinically significant for items 1-3, 9, 12, 16, and 18, and responses of *often* or *very often* qualifies as clinically significant for items 4-8, 10, 11, 13-15, and 17. Scores of 0 to 3 and 4 to 8 denote “low” and “moderate” ADHD symptoms respectively, and a score of 9 or higher indicates “clinical” range. The ASRS is divided into two sections, Part A and Part B. The first six questions in Part A have demonstrated to be most predictive of symptoms consistent with ADHD, and are best used as a screening instrument. Part B contains the remaining twelve questions based on the DSM symptom criteria (Garnier-Dykstra, Pinchevsky, Caldeira, Vincent, & Arria, 2010; Kessler et al., 2005). The ASRS has demonstrated adequate sensitivity (68.7%),

excellent specificity (99.5%), excellent total accuracy (97.9%), and positive predictive value (89.3%) (Kessler et al., 2005). In addition, internal consistency for the ASRS ranges from 0.63 and 0.72 and test-retest reliability ranges from 0.58 to 0.77 (Adler et al., 2006; see Appendix D).

Mobile App Rating Scale. The Mobile App Rating Scale (MARS; Stoyanov et al., 2015) is a 23-item tool used to assess the quality and utility of mobile health applications, and perceived level of user satisfaction. The apps are rated on four quality scales: (a) engagement – fun, interesting, customizable, interactive, well-targeted to audience; (b) functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app; (c) aesthetics – graphic design, overall visual appeal, color scheme, and stylistic consistency; and (d) information quality – contains high quality information from credible sources. The quality of each item is rated on a 5-point Likert scale (1 = *inadequate* through 5 = *excellent*). The MARS produces a total quality score and individual quality scores on engagement, functionality, aesthetics, and information quality dimensions. The measure also produces a subjective quality score and perceived impact score. The subjective quality and perceived impact is based on raters' impressions of the app, including its usability and perceived effectiveness. The MARS has demonstrated excellent internal consistency ($\alpha = 0.90$) and interrater reliability (ICC = 0.79) (Stoyanov et al., 2015; see Appendix E).

Adherence Questionnaire. Descriptive adherence measures included a one-item measure assessing motivation to continue with the study (*How motivated are you to continue this study to its completion at five weeks?*) and a one-item measure assessing confidence in ability to complete the study (*How confident are you that you will continue this to study to its completion at five weeks?*). Responses were scored on a 5-point Likert scale (1 = *not motivated/confident*, 2 = *somewhat motivated/confident*, 3 = *moderately motivated/confident*, 4 = *very*

motivated/confident, 5 = *extremely motivated/confident*). In addition, participants completed a one-item measure assessing the helpfulness of the text-message reminders in remembering to submit mindfulness practice time (*How helpful were the text-message reminders in remembering to submit mindfulness practice time?*), as well as a one-item measure assessing the helpfulness of daily text-message reminders in remembering to practice mindfulness (*How helpful were the text-message reminders in remembering to practice mindfulness?*). Responses were scored on a 5-point Likert scale (1 = *not helpful*, 2 = *somewhat helpful*, 3 = *moderately helpful*, 4 = *very helpful*, 5 = *extremely helpful*).

Materials

The Mindfulness App. Each participant downloaded *The Mindfulness App* to guide mindfulness meditation practice. This application is adaptable, and useful for beginning and experienced users of mindfulness. The app includes mindfulness meditation techniques consistent with brief and standard MBSR programs, and includes a five-day guided introduction to mindfulness. It also allows one to choose between different types of voice-guided meditations as well as silent meditations. Specifically, the app includes: (a) four guided meditations: 3, 5, 15, and 30 minutes; (b) four silent meditations with bells: 3, 5, 15, and 30 minutes; (c) one guided Arriving and Centering sitting meditation; (d) one guided Body Scan; and a (d) Personalized Meditation (with or without bells) ranging from 1 to 99 minutes. The app also allows users to set daily reminders to help them remember to engage in the mindfulness exercises as well as provides notices to increase the participant's presence in the moment. In addition, *The Mindfulness App* contains a statistics section that provides data on practice time and frequency. At the time of the study, the app required a one-time fee for download. Collaboration with app

developers allowed participants to be reimbursed for standard fees. Today, *The Mindfulness App* can now be downloaded for free from Google and iTunes stores.

Procedure

After providing informed consent (Appendix F), participants completed baseline measures that included: (a) a demographic questionnaire (see Appendix A); (b) FFMQ; (c) STAI; (d) CESD-R; and (e) ASRS. All measures were available through *SurveyMonkey*. Participants then engaged in a 1-hour group mindfulness orientation/informational session. A PowerPoint presentation was used to teach participants about mindfulness- how it works, goals, and potential outcomes. Researchers then led students through two basic mindfulness techniques: Mindfulness of Breath and Mindfulness Body Scan. Students were then given *The Mindfulness App* through iTunes for iPhone users, and Google for Android users. Participants were provided with a detailed handout explaining the apps' features.

Over the course of five weeks, participants were asked to practice mindfulness daily. EMA was implemented in order to avoid memory decay and improve participants' accuracy in documenting daily practice time. Participants were sent a reminder text at 9:00 a.m. and 9:00 p.m. All texts were sent through CallFire and included a link to *SurveyMonkey* that allowed participants to record the frequency and duration of their mindfulness practice for that day. At two weeks, participants completed the FFMQ, STAI, CESD-R, ASRS, and adherence questions. At five weeks, participants completed the MARS, FFMQ, STAI, CESD-R, ASRS, and adherence questions.

Results

Preliminary Analyses

Tests for outliers and normality of distributions for primary variables of interest showed all variables were in the acceptable range. A two-way mixed ANOVA to determine order effects on the dependent variables showed no interaction effects and no significant effect of semester, indicating participants in the Spring and Fall semesters experienced similar changes in mindfulness, $F(1, 54) = 1.577, p = .215, r = .25$; depression, $F(1, 52) = 0.730, p = .397, r = 0.12$; state anxiety, $F(1, 52) = 0.011, p = .918, r = .01$; trait anxiety, $F(1, 52) = 0.047, p = .829, r = .03$; and inattention and hyperactivity/impulsivity, $F(1, 52) = 2.193, p = .145, r = .20$ symptoms.

Changes in Mindfulness and Symptomatology

Our first hypothesis focused on changes from baseline to five-weeks on mindfulness and psychological symptoms. Thus, mean changes from baseline to five-weeks were compared using paired samples *t*-tests. Changes in all variables from pre- to post- intervention ($N = 59$) can be seen in Table 2. Pre-post effect sizes (Cohen's *d*) were calculated using the formula suggested by Dunlap, Cortina, Vaslow, and Burke (1991) for matched-pairs data ($d = M_1 - M_2 / s$). Total mindfulness scores increased significantly from baseline to post-intervention, with large effect sizes. Depression, state anxiety, trait anxiety, and inattention and impulsivity/hyperactivity symptoms all decreased significantly, also with large effect sizes.

A repeated-measures analysis of variance (ANOVA) was used to identify interactions between time (baseline [T1], two-weeks [T2], and five-weeks [T3]) and dependent variables. Mauchley's test indicated that the assumption of sphericity had been violated for the main effects of mindfulness, $\chi^2(2) = 22.13, p < .001$; depression, $\chi^2(2) = 12.35, p = .002$; state anxiety, $\chi^2(2) = 15.13, p = .001$; trait anxiety, $\chi^2(2) = 12.16, p = .002$; and inattention and

hyperactivity/impulsivity, $\chi^2(2) = 11.97, p = .003$. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\epsilon = .77$ for main effect of mindfulness, $\epsilon = .85$ for the main effect of depression, $\epsilon = .82$ for the main effect of state anxiety, $\epsilon = .85$ for the main effect of trait anxiety, and $\epsilon = .85$ for the main effect of inattention and impulsivity/hyperactivity).

There was a significant association between time and mindfulness, with mean mindfulness scores increasing over the five-week period, $F(1.64, 86.84) = 23.46, p < .001, n^2 = .39$.

Similarly, symptoms of depression, $F(1.70, 89.95) = 29.66, p < .001, n^2 = .20$; state anxiety, $F(1.64, 86.84) = 23.46, p < .001, n^2 = .21$; trait anxiety, $F(1.70, 90.19) = 26.73, p < .001, n^2 = .21$; and inattention and hyperactivity/impulsivity, $F(1.70, 90.19) = 23.46, p < .001, n^2 = .31$ declined significantly across the study period between baseline and five-week measures.

Post hoc pairwise comparisons using Bonferroni procedure were performed to determine the time period for which the observed effects occurred. These tests further revealed a significant increase in mindfulness scores between T1 and T2, T1 and T5, and T2 and T5 ($p < .01$). There was also a significant decrease in symptoms of depression, state anxiety, trait anxiety, and inattention and impulsivity/hyperactivity between each of these assessment periods ($p < .05$). Changes in all variables from baseline, two-weeks, and five-weeks ($N = 59$) can be seen in Table 3.

Text Messaging Attitudes and Adherence

Participant satisfaction of text message reminders was positive. On a scale of 0 to 5 (0 = *not helpful* and 5 = *extremely helpful*), the mean rating for the helpfulness of text-message reminders in remembering to submit mindfulness practice time was 4.43 ($SD = 0.68$). The majority of participants (53.2%) felt the text-message reminders were “extremely helpful”, 36.2% felt they were “very helpful”, and 10.6% indicated they were “moderately helpful.” We

examined whether attitudes toward text-message reminders were related to data submission adherence. For these analyses, the number of days participants submitted data were summed over the course of the five-week program. The mean number of days that participants submitted their mindfulness practice time was 32.03 (91% adherence) and the mode was 35 (100% adherence). Despite favorable attitudes, there was no significant association between attitudes towards text-message reminders and total number of days submitted, $r = -.196, p = .187$.

The mean rating for the helpfulness of text-message reminders in remembering to practice mindfulness was 3.94 ($SD = 1.19$). Approximately 85.2% of participants felt the text-message reminders were at least moderately helpful (Likert score of 3 or higher) in remembering to practice mindfulness, 10.6% felt they were “somewhat helpful”, and 4.3% stated they were “not helpful”. To examine whether attitudes toward text-message reminders were related to treatment adherence, daily mindfulness practice times were summed, yielding a total practice time over the course of the five-week program. To determine average practice time per day, total practice time was then divided by the total number of days each participant practiced. The mean total practice time was 248.24 ($SD = 187.24$) minutes, and the mean practice time per day was 7.75 ($SD = 5.83$) minutes. Despite favorable attitudes, there was no significant relationship between attitudes towards text-message reminders and total practice time, $r = -.057, p = .701$, and average practice time per day, $r = .041, p = .786$.

Attitudes Towards *The Mindfulness App*

The MARS survey indicated participants’ overall positive attitudes toward *The Mindfulness App*. Means and standard deviations for each scale can be seen in Table 4. On a scale of 0 to 5 (1 = *inadequate* and 5 = *excellent*), ratings for overall quality and subjective quality were moderate to high. Subscale scores further indicated favorable attitudes towards app

engagement, functionality, aesthetics, and information quality. Despite favorable attitudes, only subjective quality ratings were associated with total mindfulness practice time, $r = .265$, $p = .043$.

The MARS survey also assessed the perceived impact of the app on the users' knowledge, attitudes, intentions to change, as well as the likelihood of change in the target behavior. The majority of participants (64.4%) indicated that the app was likely to increase awareness of the importance of practicing mindfulness. Further, 71.2% agreed the app is likely to increase knowledge and understanding of mindfulness, 74.6% agreed the app is likely to change attitudes towards improving/increasing mindfulness meditation, and 66.1% agreed the app is like to increase motivation to practice mindfulness. In addition, 66.1% reported the use of this app is likely to encourage help seeking behaviors for mindfulness-based therapies. Further, there was a significant association between participants' attitudes towards future help seeking behaviors and total mindfulness practice time, $r = .285$, $p = .029$.

Discussion

College populations are vulnerable to psychological disorders (Clark et al., 1999; Gallagher, 2006; Hunt & Eisenberg, 2010); therefore, access to programs to prevent and manage these symptoms and improve health outcomes is needed. To date, this is one of the first studies to demonstrate the feasibility of using a mindfulness-based mobile app with college students (Plaza et al., 2013). The purpose of this study was to assess the effectiveness of *The Mindfulness App* for improving mental health by assessing changes in mindfulness and symptomatology. We also examined the utility of text-message reminders for increasing adherence to study protocol as well as mindfulness practice. Finally, we assessed college students' perceptions of the mindfulness smartphone app.

The primary aim of this study was to investigate whether participation in the brief-mindfulness intervention using *The Mindfulness App* would lead to changes in mindfulness, depression, anxiety, and inattention and hyperactivity/impulsivity symptoms. Consistent with the hypothesis, results indicated participants experienced significant increases in mindfulness from pre- to post- intervention, which is similar to Canby et al. (2015) who also found an increase in mindfulness following a mindfulness-based intervention. There were also significant decreases in symptomatology over the course of the five-week intervention. These symptom reductions in mean scores are similar to observed changes with more intensive mindfulness programs (Bamber & Schneider, 2015; Holzel et al., 2011; Vince et al., 2014). Overall, the magnitude of improvement in outcome measures of the mindfulness mobile app is comparable to traditional face-to-face mindfulness programs (Baer et al., 2012). This study provides preliminary support for the efficacy of an abbreviated mindfulness-based intervention delivered using a mobile phone.

The benefits of the program were also seen at two-weeks for all dependent measures, demonstrating that *The Mindfulness App* can impact mindfulness and psychological functioning in a shorter time-frame than the recommended brief (five-week) and standard (eight-week) MBSR programs. Previous research identified time pressures as a primary reason why college students do not seek mindfulness-based interventions (Aherne et al., 2016). Thus, this study was designed to be as efficient as possible by adopting a brief-MBSR protocol. The decreased time requirement appeared to be effective for college students, and demonstrated that significant results can be achieved within a relatively short, two-week time frame. However, it is not known if the effects would extend past two-weeks without regular practice or last longer than five-weeks. Thus, future evaluations should introduce short-term and long-term follow-up

assessments in order to investigate whether the effects of the app last after completion of the treatment intervention.

Text-message reminders were an important addition to this study because they have demonstrated effectiveness in improving adherence in psychological and medical interventions (Car et al., 2012; Thirumurthy, & Lester, 2012). Furthermore, text-messaging has been useful in collecting and sharing information as well as assisting individuals with keeping appointments, clinical monitoring, and symptom management in both clinical and nonclinical populations (Fjeldsoe et al., 2009; Mukund Bahadur & Murray, 2010). Thus, we hypothesized that text-message reminders would be perceived as a helpful means for increasing adherence to study protocol and mindfulness practice.

Participants in this study reported that text message reminders improved adherence to data submissions as well as treatment adherence. Adherence is especially relevant in mindfulness interventions as regular practice is essential for developing mindfulness skills (Baer et al., 2012). Nonadherence is high in psychotherapy, behavior therapy, and treatments requiring lifestyle changes, with rates ranging from 30% to 70% (Martin et al., 2005; Wierzbicki & Pekarik, 1993). In this study, participant adherence to data submission was greater than most treatments. The mean number of days participants submitted their mindfulness practice time was 32.03 (91% adherence) and the mode was 35 (100% adherence). Despite favorable perceptions, there was no significant relationship between attitudes towards text-message reminders and total number of days participants engaged in and submitted mindfulness practice time. Therefore, high adherence rates may be indicative of the participants' positive response to the intervention approach and successful adoption of formal meditation practice. The portability of the mobile

phone which allows for flexible usage may also account for this high adherence rate (Proudfoot et al., 2010).

This study also achieved high retention rates among participants (59 of 63 participants, or 94%). Consistent with previous studies (Car et al., 2012; Fjeldsoe et al., 2009; Mukund Bahadur & Murray, 2010; Thirumurthy & Lester, 2012), text-message reminders may have contributed to these higher levels. The reasons for retention, however, were not systematically explored in this study. Therefore, whether text-messaging is a useful means of improving retention in mindfulness-based mobile interventions remains unknown. Future research examining the relationship between retention and different modes (e.g., text-messaging, email, face-to-face) and frequencies of contact between researchers and participants should be explored. Furthermore, because participants were offered incentives (i.e., research and course credit, raffle prize) for participation, the influences of motivational factors on retention should also be examined.

While there are hundreds of mindfulness mobile apps available, there is little information on their quality (Donker et al., 2013; Plaza et al., 2013). Therefore, we evaluated *The Mindfulness App* using a recently developed rating scale, the Mobile App Rating Scale (MARS). The final hypothesis of this study was that participants would report positive attitudes toward *The Mindfulness App*. Overall, usability, helpfulness, and satisfaction ratings were positive. Participants agreed that the impact of *The Mindfulness App* is likely to change users' knowledge of and attitudes toward mindfulness interventions. Furthermore, participants indicated that use of the app is likely to encourage intentions to change and increase mindfulness practice of future users. It is likely that participants' positive views of the app assisted in maintaining higher retention and adherence rates.

Participants also reported favorable perceptions of the app's engagement, functionality, aesthetics, and information quality. Previous research has demonstrated a positive association between patient experience and clinical outcomes (Doyle et al., 2013). Therefore, participant satisfaction may have also enhanced the impact of the intervention. Available technologies are constantly developing and changing. As a result, most apps lack evidence-based content. In order to maximize effectiveness, it is crucial that future studies examine whether developers incorporate high-quality, data driven content as well as which features of the app are perceived as most effective by users.

Limitations

Preliminary findings suggest empirical support for *The Mindfulness App*. However, the following limitations should be considered. Due to the lack of racial diversity and our use of a convenience sample taken from a mid-sized Midwestern University, results may not be generalizable to the overall college population, particularly larger Universities in different regions. There are also differences between obligations and academic demands between freshman and senior year of college. Therefore, because the majority of our sample was underclassman (84.7%), generalizability to older college students may be limited. Furthermore, all participants were students in psychology courses who were offered incentives for participation. These motivating factors could affect how they answered questions on surveys and their willingness to participate. Future studies should assess the effectiveness of *The Mindfulness App* with participants of different demographic profiles while also controlling for confounding motivational influences.

The lack of control group for this study is also a limitation. The efficacy of brief MBSR in increasing mindfulness and reducing psychological symptoms has, however, been shown in

controlled studies (Bergen-Cico et al., 2013; Mrazek & Schooler, 2013). Although there were no significant differences between the Spring and Fall semester groups, a control group would have provided the additional advantage of ensuring the observed effects were due to the treatment. Future studies are recommended to evaluate whether *The Mindfulness App* improves outcomes relative to groups without the app. Furthermore, text-message alerts were independent from *The Mindfulness App*. Therefore, future research should compare groups with and without text-message reminders to clarify whether the identified changes in mindfulness and psychological functioning are unique to *The Mindfulness App* intervention or a result of the reminders. In addition, future studies should assess whether text-message reminders can change participants' motivation to practice mindfulness.

Careful assessment of participants' adherence to their assigned technique and quality of mindfulness meditation might also be useful. *The Mindfulness App* is currently limited by its inability to automatically transmit raw and calculated data through dashboards to other users such as the researcher or clinician. Having this capability would be a significant step towards increasing the efficiency of this data-intensive protocol because it removes the need for alternative forms of data collection (e.g., daily logs). Objective measures of adherence transmitted through dashboards could also improve the accuracy of self-report data and eliminate the potential confounds of memory decay.

Conclusions

A large proportion of college students report significant stress-related health concerns (Clark et al., 1999; Hunt & Eisenberg, 2010). These concerns impact students psychologically, academically, and interpersonally (Bergen-Cico et al., 2013; D'Zurilla & Sheedy, 1991; Struthers et al., 2000). The results of this study show that a brief-mindfulness program utilizing

a mindfulness-based mobile app was effective in improving mindfulness and mental health for college students. Furthermore, findings suggest the app was effective in increasing retention and adherence to the treatment protocol.

The mobile revolution is offering an opportunity to provide clinical support when and where people need it. The vast array of mobile health-related apps provides individuals with a unique opportunity to achieve their healthcare goals and overcome obstacles (e.g., adherence, self-monitoring, etc.). Many college students report lack of time for or accessibility to mindfulness meditation training programs with certified instructors (Aherne et al., 2016). The ability to access mindfulness programs using mobile-based technology at little cost would greatly facilitate engagement in mindfulness practice among interested individuals. Given increased digital access, especially among youth, mobile apps may be a more convenient and cost-effective strategy compared to traditional face-to-face interventions. Therefore, college counseling centers and other agencies that seek to provide efficient, cost-effective interventions for this population may benefit from use of *The Mindfulness App*.

The increased popularity of mobile apps has a number of implications for its delivery of mental health services. Effective use of mobile apps has the potential to increase quality of care and access to evidence-based treatments through technology. As the mental health field continues to incorporate new technologies into practice, it is imperative to investigate the effectiveness, feasibility, and usability of mindfulness mobile apps in an effort to increase access to high-quality evidence-based treatments.

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Table 1
Characteristics of Participants

Variable	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
	Total	Spring	Fall
	59 (100)	12 (20.3)	47 (79.7)
Gender			
Female	44 (74.6)	10 (83.3)	34 (72.3)
Male	15 (25.4)	2 (16.7)	13 (27.7)
Student status			
Freshman	35 (59.3)	7 (58.3)	28 (59.6)
Sophomore	15 (25.4)	4 (33.3)	11 (23.4)
Junior	7 (11.9)	1 (8.3)	6 (12.8)
Senior	2 (3.4)	0	2 (4.3)
Ethnicity			
Caucasian	52 (88.1)	11(91.7)	41 (87.2)
African American/ Black	2 (3.4)	1 (8.3)	1 (2.1)
Hispanic/ Latino	4 (6.8)	0	4 (8.5)
Asian/ Pacific Islander	1 (1.7)	0	1 (2.1)
Current diagnoses			
Anxiety	4 (6.8)	0	4 (8.5)
Depression	2 (3.4)	0	2 (4.3)
ADHD	3 (5.1)	1 (8.3)	2 (4.3)
Anxiety + Depression	6 (10.2)	3 (25.0)	3 (6.4)
Anxiety + Depression + ADHD	1 (1.7)	0	1 (2.1)
None	43 (72.9)	8 (66.7)	35 (74.5)
Medication			
Yes	14 (23.7)	3 (25.0)	11 (23.4)
No	45 (76.3)	9 (75.0)	36 (76.6)

Note. ADHD = attention deficit/hyperactivity disorder

Table 2
Comparison of Pre-Post Scores for All Variables

Variable	Pre-test		Post -test		<i>t</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Mindfulness	2.88	0.47	3.55	0.51	- 9.21***	1.43
Depression	20.00	12.23	11.22	11.47	6.56***	-0.72
State Anxiety	45.37	11.77	35.58	10.85	5.56***	-0.90
Trait Anxiety	48.69	11.14	39.44	10.44	6.44***	-0.83
Inattention & Impulsivity/ Hyperactivity	8.54	5.62	3.34	3.21	7.59***	-0.93

Note. *** $p < .001$

Table 3
Results of Post Hoc Pairwise Comparisons for Variables at Each Time Period

Measure	Time	Mean Difference
Mindfulness (FFMQ)	T1 – T2	-0.39**
	T1 – T3	-0.67**
	T2 – T3	-0.28**
Depression (CESD-R)	T1 – T2	6.35**
	T1 – T3	9.07**
	T2 – T3	2.72**
State Anxiety (STAI)	T1 – T2	7.07**
	T1 – T3	10.24**
	T2 – T3	3.17*
Trait Anxiety (STAI)	T1 – T2	5.15**
	T1 – T3	9.33**
	T2 – T3	4.19**
Inattention & Impulsivity/hyperactivity (ASRS)	T1 – T2	3.89**
	T1 – T3	5.44**
	T2 – T3	1.56**

Note. * $p < .05$, ** $p < .01$; T1 = baseline; T2 = two weeks; T3 = five weeks

Table 4

Means and Standard Deviations for Mobile App Rating Scale (MARS) Quality Scales

MARS Scale	<i>M</i>	<i>SD</i>
Engagement	3.32	0.80
Functionality	4.20	0.67
Aesthetics	4.07	0.66
Information Quality	4.12	0.66
Subjective Quality	3.33	0.60
Overall Quality	3.93	0.59
Perceived Impact - Awareness	3.78	0.83
Perceived Impact - Knowledge	3.86	0.94
Perceived Impact - Attitudes	4.00	0.85
Perceived Impact - Intention to Change	3.92	0.86
Perceived Impact - Help Seeking	3.83	0.87

Note. All items were scored on a 0 to 5 Likert scale (1 = *inadequate* and 5 = *excellent*).

Appendix A
Demographic Information

Age: _____

Gender:

_____ Male

_____ Female

_____ Other (please specify) _____

Ethnicity:

_____ African American/ Black

_____ Asian / Pacific Islander

_____ Hispanic/Latino

_____ Native American

_____ White/ Caucasian

_____ Other (please specify) _____

Current Class Status:

_____ Freshman

_____ Sophomore

_____ Junior

_____ Senior

_____ Graduate Student

_____ Other (please specify) _____

Contact information:

Email address: _____

Cellphone number: _____

Appendix B
Five-Facet Mindfulness Questionnaire

Please rate each of the following statements using the scale provided, by using the number that best describes your own opinion of what is generally true for you.

- 1 = never or very rarely true
- 2 = rarely true
- 3 = sometimes true
- 4 = often true
- 5 = always true

1. When I'm walking, I deliberately notice the sensations of my body moving
2. I'm good at finding words to describe my feelings.
3. I criticize myself for having irrational or inappropriate emotions.
4. I perceive my feelings and emotions without having to react to them.
5. When I do things, my mind wanders off and I'm easily distracted.
6. When I take a shower or bath, I stay alert to the sensations of water on my body.
7. I can easily put my beliefs, opinions, and expectations into words
8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
9. I watch my feelings without getting lost in them.
10. I tell myself I shouldn't be feeling the way I'm feeling.
11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
12. It's hard for me to find the words to describe what I'm thinking.
13. I am easily distracted.
14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
15. I pay attention to sensations, such as the wind in my hair or sun on my face.
16. I have trouble thinking of the right words to express how I feel about things.
17. I make judgments about whether my thoughts are good or bad.
18. I find it difficult to stay focused on what's happening in the present.
19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting take over by it.
20. I pay attention to sounds, such as clocks, ticking, birds chirping, or cars passing.
21. In difficult sensations, I can pause without immediately reacting.
22. What I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
23. It seems I am "running on automatic" without much awareness of what I'm doing.
24. What I have distressing thoughts or images, I feel calm soon after.
25. I tell myself that I shouldn't be thinking the way I'm thinking.
26. I notice the smells and aromas of things.
27. Even when I'm feeling terribly upset, I can find a way to put it into words.

28. I rush through activities without being really attentive to them.
29. When I have distressing thoughts or images, I am able just to notice them without reacting.
30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
32. My natural tendency is to put my experiences into words.
33. When I have distressing thoughts or images, I just notice them and let them go.
34. I do jobs or tasks automatically without being aware of what I'm doing.
35. When I have distressing thoughts or images, I judge myself as good or bad depending what the thought or image is about.
36. I pay attention to how my emotions affect my thoughts and behavior.
37. I can usually describe how I feel at the moment in considerable detail.
38. I find myself doing things without paying attention.
39. I disapprove of myself when I have irrational ideas.

Appendix C
Center for Epidemiologic Studies Depression Scale Revised (CESD-R)

Below is a list of the ways you might have felt or behaved. Please rate how often you have felt this way during the past week.

- 0 = Not at all or Less than 1 day
- 1 = 1 or 2 days
- 2 = 3 to 4 days
- 3 = 5 to 7 days
- 4 = Nearly every day for 2 weeks

1. My appetite was poor.
2. I could not shake off the blues.
3. I had trouble keeping my mind on what I was doing.
4. I felt depressed.
5. My sleep was restless.
6. I felt sad.
7. I could not get going.
8. Nothing made me happy.
9. I felt like a bad person.
10. I lost interest in my usual activities.
11. I slept much more than usual.
12. I felt like I was moving too slowly.
13. I felt fidgety.
14. I wished I were dead.
15. I wanted to hurt myself.
16. I was tired all the time.
17. I did not like myself.
18. I lost a lot of weight without trying to.
19. I had a lot of trouble getting to sleep.
20. I could not focus on the important things.

Appendix D
Adult ADHD Self-Report Scale (ASRS)

Please answer the questions below, rating yourself on each of the criteria shown using the 5-point rating scale. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months.

- 1 = Never
- 2 = Rarely
- 3 = Sometimes
- 4 = Often
- 5 = Very Often

1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?
2. How often do you have difficulty getting things in order when you have to do a task that requires organization?
3. How often do you have problems remembering appointments or obligations?
4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?
5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?
6. How often do you feel overly active and compelled to do things, like you were driven by a motor?
7. How often do you make careless mistakes when you have to work on a boring or difficult project?
8. How often do you have difficulty keeping your attention when you are doing boring or repetitive work?
9. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?
10. How often do you misplace or have difficulty finding things at home or at work?
11. How often are you distracted by activity or noise around you?
12. How often do you leave your seat in meetings or other situations in which you are expected to remain seated?
13. How often do you feel restless or fidgety?
14. How often do you have difficulty unwinding and relaxing when you have time to yourself?
15. How often do you find yourself talking too much when you are in social situations?
16. When you're in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish them themselves?
17. How often do you have difficulty waiting your turn in situations when turn taking is required?
18. How often do you interrupt others when they are busy?

Appendix E
Mobile App Rating Scale (MARS)

App Quality Ratings

The Rating scale assesses app quality on four dimensions. All items are rated on a 5-point scale from 1 “*Inadequate*” to 5 “*Excellent*”. Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

SECTION A: Engagement – fun, interesting, customizable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience**1. Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?**

- 1 Dull, not fun or entertaining at all
- 2 Mostly boring
- 3 OK, fun enough to entertain user for a brief time (< 5 minutes)
- 4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)
- 5 Highly entertaining and fun, would stimulate repeat use

2. Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?

- 1 Not interesting at all
- 2 Mostly uninteresting
- 3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)
- 4 Moderately interesting; would engage user for some time (5-10 minutes total)
- 5 Very interesting, would engage user in repeat use

3. Customization: Does it provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.)?

- 1 Does not allow any customization or requires setting to be input every time
- 2 Allows insufficient customization limiting functions
- 3 Allows basic customization to function adequately
- 4 Allows numerous options for customization
- 5 Allows complete tailoring to the individual’s characteristics/preferences, retains all settings

4. Interactivity: Does it allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.)? Note: these functions need to be customizable and not overwhelming in order to be perfect.

- 1 No interactive features and/or no response to user interaction
- 2 Insufficient interactivity, or feedback, or user input options, limiting functions
- 3 Basic interactive features to function adequately
- 4 Offers a variety of interactive features/feedback/user input options
- 5 Very high level of responsiveness through interactive features/feedback/user input options

5. Target group: Is the app content (visual information, language, design) appropriate for your target audience?

- 1 Completely inappropriate/unclear/confusing
- 2 Mostly inappropriate/unclear/confusing
- 3 Acceptable but not targeted. May be inappropriate/unclear/confusing
- 4 Well-targeted, with negligible issues
- 5 Perfectly targeted, no issues found

SECTION B: Functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app

6. Performance: How accurately/fast do the app features (functions) and components (buttons/menus) work?

- 1 App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken features, etc.)
- 2 Some functions work, but lagging or contains major technical problems
- 3 App works overall. Some technical problems need fixing/Slow at times
- 4 Mostly functional with minor/negligible problems
- 5 Perfect/timely response; no technical bugs found/contains a 'loading time left' indicator

7. Ease of use: How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?

- 1 No/limited instructions; menu labels/icons are confusing; complicated
- 2 Useable after a lot of time/effort
- 3 Useable after some time/effort
- 4 Easy to learn how to use the app (or has clear instructions)

5 Able to use app immediately; intuitive; simple

8. Navigation: Is moving between screens logical/accurate/appropriate/ uninterrupted; are all necessary screen links present?

1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult

2 Usable after a lot of time/effort

3 Usable after some time/effort

4 Easy to use or missing a negligible link

5 Perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts

9. Gestural design: Are interactions (taps/swipes/pinches/scrolls) consistent and intuitive across all components/screens?

1 Completely inconsistent/confusing

2 Often inconsistent/confusing

3 OK with some inconsistencies/confusing elements

4 Mostly consistent/intuitive with negligible problems

5 Perfectly consistent and intuitive

SECTION C: Aesthetics – graphic design, overall visual appeal, colour scheme, and stylistic consistency

10. Layout: Is arrangement and size of buttons/icons/menus/content on the screen appropriate or zoomable if needed?

1 Very bad design, cluttered, some options impossible to select/locate/see/read. Device display not optimized.

2 Bad design, random, clear, some options difficult to select/locate/see/read.

3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen-size problems.

4 Mostly clear, able to select/locate/see/read items.

5 Professional, simple, clear, orderly, logically organized, device display optimized. Every design component has a purpose.

11. Graphics: How high is the quality/resolution of graphics used for buttons/icons/menus/content?

1 Graphics appear amateur, very poor visual design - disproportionate, completely stylistically inconsistent.

- 2 Low quality/low resolution graphics; low quality visual design – disproportionate, stylistically inconsistent.
- 3 Moderate quality graphics and visual design (generally consistent in style).
- 4 High quality/resolution graphics and visual design – mostly proportionate, stylistically consistent.
- 5 Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout.

12. Visual appeal: How good does the app look?

- 1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colours
- 2 Little visual appeal – poorly designed, bad use of colour, visually boring
- 3 Some visual appeal – average, neither pleasant, nor unpleasant
- 4 High level of visual appeal – seamless graphics – consistent and professionally designed
- 5 As above + very attractive, memorable, stands out; use of colour enhances app features/menus

SECTION D: Information – Contains high quality information (e.g. text, feedback, measures, references) from a credible source. Select N/A if the app component is irrelevant.

13. Accuracy of app description (in app store): Does app contain what is described?

- 1 Misleading. App does not contain the described components/functions, or has no description
- 2 Inaccurate. App contains very few of the described components/functions
- 3 OK. App contains some of the described components/functions
- 4 Accurate. App contains most of the described components/functions
- 5 Highly accurate description of the app components/functions

14. Goals: Does app have specific, measurable and achievable goals (specified in app store description or within the app itself)?

N/A Description does not list goals, or app goals are irrelevant to research goal (e.g. using a game for educational purposes)

- 1 App has no chance of achieving its stated goals
- 2 Description lists some goals, but app has very little chance of achieving them
- 3 OK. App has clear goals, which may be achievable.
- 4 App has clearly specified goals, which are measurable and achievable
- 5 App has specific and measurable goals, which are highly likely to be achieved

15. Quality of information: Is app content correct, well written, and relevant to the goal/topic of the app?

- N/A There is no information within the app
- 1 Irrelevant/inappropriate/incoherent/incorrect
- 2 Poor. Barely relevant/appropriate/coherent/may be incorrect
- 3 Moderately relevant/appropriate/coherent/and appears correct
- 4 Relevant/appropriate/coherent/correct
- 5 Highly relevant, appropriate, coherent, and correct

16. Quantity of information: Is the extent coverage within the scope of the app; and comprehensive but concise?

- N/A There is no information within the app
- 1 Minimal or overwhelming
- 2 Insufficient or possibly overwhelming
- 3 OK but not comprehensive or concise
- 4 Offers a broad range of information, has some gaps or unnecessary detail; or has no links to more information and resources
- 5 Comprehensive and concise; contains links to more information and resources

17. Visual information: Is visual explanation of concepts – through charts/graphs/images/videos, etc. – clear, logical, correct?

- N/A There is no visual information within the app (e.g. it only contains audio or text)
- 1 Completely unclear/confusing/wrong or necessary but missing
- 2 Mostly unclear/confusing/wrong
- 3 OK but often unclear/confusing/wrong
- 4 Mostly clear/logical/correct with negligible issues
- 5 Perfectly clear/logical/correct

18. Credibility: Does the app come from a legitimate source (specified in app store description or within the app itself)?

- 1 Source identified but legitimacy/trustworthiness of source is questionable (e.g. commercial business with vested interest)

- 2 Appears to come from a legitimate source, but it cannot be verified (e.g. has no webpage)
- 3 Developed by small NGO/institution (hospital/center, etc.) /specialized commercial business, funding body
- 4 Developed by government, university or as above but larger in scale
- 5 Developed using nationally competitive government or research funding (e.g. Australian Research Council, NHMRC)

19 Evidence base: Has the app been trialed/tested; must be verified by evidence (in published scientific literature)?

- 1 The evidence suggests the app does not work
- 2 App has been trialed and has partially positive outcomes in studies that are not randomized controlled trials (RCTs) if there is little or no contradictory evidence.
- 3 App has not been trialed (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is not contradictory evidence.
- 4 App has been trialed and outcome tested in 1-2 RCTs indicating positive results
- 5 App has been trialed and outcome tested in > 3 high quality RCTs indicating positive results

20 Would you recommend this app to people who might benefit from it?

1. Not at all, I would not recommend this app to anyone
2. There are very few people I would recommend this app to
- 3 Maybe, there are several people whom I would recommend it to
4. There are many people I would recommend this app to
5. Definitely, I would recommend this app to everyone

21. How many times do you think you would use this app in the next 12 months if it was relevant to you?

- 1 None
- 2 1-2
- 3 3-10
- 4 10-50
- 5 >50

22. Would you pay for this app?

1 No

3 Maybe

5 Yes

23. What is your overall star rating of the app?

1 * One of the worst apps I've used

2 * *

3 * * * Average

4 * * * *

5 * * * * * One of the best apps I've used

SECTION F: Awareness: This app is likely to increase awareness of the importance of addressing mindfulness meditation.

Strongly Disagree

Strongly Agree

1 2 3 4 5

Knowledge: This app is likely to increase knowledge/understanding of mindfulness meditation.

Strongly Disagree

Strongly Agree

1 2 3 4 5

Attitudes: This app is likely to change attitudes toward improving/increasing mindfulness meditation.

Strongly Disagree

Strongly Agree

1 2 3 4 5

Intention to change: This app is likely to increase intentions/motivation to address mindfulness meditation.

Strongly Disagree

Strongly Agree

1 2 3 4 5

Help seeking: Use of this app is likely to increase mindfulness meditation.

Strongly Disagree

Strongly Agree

1 2 3 4 5

Appendix F Informed Consent

The Department of Psychology supports the practice of protection for human subjects participating in research. The following information is provided so that you can decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.

Purpose: The present research aims to better understand a mindfulness mobile application. The goal of this study is to look at the relationship between mindfulness meditation practice and health.

Eligibility Criteria: You have been asked to take part in this study if you are at least 18 years of age and are enrolled in college courses. Since this is a study testing a mobile phone application, ownership of an iPhone or Android mobile phone is required.

Procedure: If you agree to participate, you can expect the following:

- (1) You will be asked to complete a questionnaire with your name, age, gender, ethnicity, current class status (e.g., freshman, sophomore, etc.), and contact information.
- (2) You will complete a series of online, self-report surveys three times over the next several weeks. You will also attend a one-hour mindfulness-based stress reduction (MBSR) training session.
- (3) Over the course of five weeks, you will practice mindfulness meditation using *The Mindfulness App*. Each day, you will be required to record the frequency and duration of your meditation practice. Text-message reminders will be sent to your phone twice per day, and will include a link to submit amount of mindfulness practice.

Benefits and Risks: Mindfulness has been shown to improve mind-body awareness and health. Your participation in this study will also inform knowledge of college student well-being. The study creates a minimal risk to loss of privacy. CallFire technology used to send text-message updates uses security measures to ensure customer information is safe, secure, and only available to the customer to whom the information belongs. A potential risk to participating in this study is that answering some survey questions may cause discomfort.

Compensation: You will be given *The Mindfulness App*. iPhone users will be provided a free code to download the application. **Android users will need to buy the application, but will be compensated for their purchase.** Detailed information about the process of receiving compensation will be provided upon request. Participants will not be paid to participate in this research project. However, you can receive up to 50 research points for your PY100 class for participating. If you are enrolled in a class other than PY 100, your instructor will decide what credit you will receive for participating in this study. **Confidentiality and Privacy of Information:** Access to your information will be limited to the researchers. Your privacy will be protected by keeping all of your information on a password-protected computer. In addition, your information will be associated with a number assigned to you rather than your name. Information obtained during the study will be kept confidential. Any publications or reports will use summary information rather than individually identifiable information. Thus, your name will not be associated with your information. **Agreement:** Your participation is solicited, but strictly voluntary. This agreement states that you have received a copy of this informed consent. Your signature below indicates that you agree to participate in this study. For any questions concerning the research project, you can call Kelsey Moffitt 913-314-6465.

Participant Name (Print): _____ **Code:** XXXXXX

Participant Signature: _____ **Date:** _____