2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #38072

The Impact of Short Mindfulness Practices on Student Attention and Focus in Upper-Level Civil Engineering Design Class

Dr. Priyantha Wijesinghe, University of Vermont

Priyantha Wijesinghe is a Senior Lecturer in Civil and Environmental Engineering and Director of Curricular Enrichment for the College of Engineering and Mathematical Sciences (CEMS) at the University of Vermont (UVM). Priyantha is a structural engineer and architect by education and is an engineering education and assessment expert. As the Director of curricular enrichment, she has organized and facilitated numerous teaching and assessment workshops to enhance the teaching and learning experience for CEMS faculty and students across five engineering programs, mathematics and statistics, and computer science. She also served as the ABET coordinator for five engineering programs in 2021 reaccreditation visit. She has been teaching sophomore to graduate level engineering mechanics and civil and structural engineering courses since 2011 at UVM. Priyantha is also an active member of the Contemplative Practices Learning Community of the University's Center for Teaching and Learning. She practices mindfulness meditations rooted in Theravada Buddhist tradition and has been incorporating mindfulness practices in her classes since 2019.

Dr. Holly Ann Buckland Parker, University of Vermont

Holly Buckland Parker is an educational developer at the Center for Teaching and Learning at the University of Vermont (UVM). Holly coordinates the Graduate Teaching Program and conducts workshops on pedagogy and educational technologies. Dr. Buckland Parker continues to work on her research interests regarding the implementation of Universal Design for Learning (UDL) and inclusive teaching practices in Higher Education. Holly is also a part-time faculty member in the Higher Education and Student Affairs Program in the College of Education and Social Services at the University of Vermont. She teaches graduate courses on the implementation of anti-racist teaching practices, inclusive teaching pedagogy, and UDL in the higher education context. Holly is an active member of the Contemplative Practices Learning Community at the UVM Center for Teaching and Learning. She has her own mindfulness practice and strives to incorporate mindfulness practices into classrooms and meetings on the UVM campus.

WIP: The impact of short mindfulness practices on student attention and focus in upper-level civil engineering design class

Introduction

This work-in-progress (WIP) research study investigates the impact of short mindfulness practices on student attention and focus in an upper-level civil engineering design course. Even though numerous studies have shown a positive correlation between mindfulness activities and student focus and attention, intervention studies focused on specific student groups in engineering still need to be included [1-3].

Twenty-one upper-level civil engineering students in the Structural Steel Design course participated in this study. Students were offered 3-5-minute mindfulness practices at the beginning of each 50-min class period, including mindful breathing, awareness, observation, listening, and meditations such as lovingkindness and gratitude. Once a week, other contemplative activities labeled 'Nuggets of Wisdom,' which included a variety of reflective writing, deep listening, insight mediations, and mindful conversations, were offered. Qualitative and quantitative data were gathered through weekly surveys, student focus group (SFG) interviews, direct observations by the instructor, and participants' scores in follow-up assignments and their overall semester performance. In addition to a demographic survey, weekly surveys included the Freiburg Mindfulness Inventory (FMI) [4], one of the best-established and widely used questionnaires for self-assessment of mindfulness [5]. This WIP paper includes only the aggregate results from weekly surveys and the SFG report. The aggregate results of the study show promising upward trends in students' overall mindfulness, attention, and focus. Furthermore, the instructor's observations and students' written responses indicated civil engineering students' receptiveness to practice mindfulness in class, agreeing with similar findings by other scholars on engineering students [1, 6].

Mindfulness: Having roots in ancient Buddhism, mindfulness practices today have become a mainstream tool for managing and alleviating stress in individuals of different backgrounds. According to the American Psychological Association (APA), mindfulness is an awareness of one's internal states and surroundings [7]. A broader and holistic definition of mindfulness is given by Shapiro [8] by incorporating three key terms: Intention, Attention, and Attitude: "The awareness that arises through intentionally attending in an open, accepting, and discerning way to whatever is arising in the present moment" [9]. This captures both aspects of mindfulness: the outcome (mindful awareness) and process (mindful practice) [8, 9]. Adopting the key aspects of both [7] and [8] definitions and with the authors' interpretation, mindfulness is defined in this study as (i) awareness or knowing when thoughts arise, (ii) paying attention to what is arising in the form of thoughts, feelings, and sensations, and (iii) observing them non-judgmentally with an attitude of kindness and curiosity.

State and Trait Mindfulness: Mindfulness research in academia falls into two main categories [10], state and trait mindfulness. Trait mindfulness refers to dispositional mindfulness - the type of mindfulness that occurs over time and has become part of a person's personality. State mindfulness or a short-term level of mindfulness is related to the experience at the present

moment. It occurs immediately after the mindfulness activity. Most mindfulness research in engineering investigates the effect of trait mindfulness on student performance and well-being. This study is mainly focused on measuring state mindfulness. However, the data collected through this study may also help track an individual's trait mindfulness. Research has shown that trait mindfulness can occur with continued practice of mindfulness [11], and such continued practice can make measurable changes in the brain's activity and physical structure [12].

Attention and Focus: APA defines attention as the "state in which cognitive resources are focused on certain aspects of the environment rather than on others, and the central nervous system is in a state of readiness to respond to stimuli" [7]. Attention in psychology has many subcategories, which is not the focus of this study. This study considers attention a key component of mindfulness and thus interprets it as one's ability to stay in the present moment. The focus will be on sustained attention – a skill required to maintain an awareness of current experience [13]. It is worth noting that both Focused Attention Meditation (FAM) and Open Monitoring Meditation (OMM) reduce mind-wondering (see [14] for a comprehensive analysis) and therefore are equally important in mindfulness practices. The study adopts the APA definition of attention span, "the length of time an individual can concentrate on one specific task or other items of interest," and focus, "concentration or centering of attention on a stimulus" [7].

Literature Review

Mindfulness has been widely shown to improve cognitive functioning and overall psychological well-being in the academic setting (see [15] & [16] for a comprehensive review). Mindfulness meditation has been proven to significantly decrease stress and anxiety in college students [11]. Some scholars have researched the relationship between mindfulness, cognitive function, and stress. Results of one such study [17] show that all facets of trait mindfulness are significantly associated with cognitive abilities and cognitive concerns via perceived stress, but the results didn’t find a correlation between trait mindfulness and academic achievement.

Mindfulness practices and student performance in STEM: Within the growing literature on mindfulness in academia, only limited research has been performed in STEM disciplines, specifically engineering [6]. Some studies suggest that engineering students are representative of the general population of undergraduate students on self-report mindfulness instruments [16]. This statement needs further investigation before generalizing such research results and applying the recommendations to undergraduate engineering education.

In mathematics settings, it has been shown that mindfulness may allow students to stay focused in anxiety-producing high-stake testing environments [15]. However, this applied to students with greater mindfulness (trait mindfulness) and was more evident when the task demanded significant working memory resources [15]. Another study [16], including 75 students in an introductory solid mechanics course, measured students' self-reported trait mindfulness at the time of completing the mindfulness instruments. This study did not conduct mindfulness training with the students. However, the self-reported mindfulness measures revealed that trait mindfulness does not correlate with students' final grades or mechanics self-efficacy but positively correlates with business skills self-efficacy. The study further suggests that mindfulness-based classroom activities may help broaden the engineering education experience.

Some research results suggest that mindfulness practices apply to engineering and that they can be successfully included in engineering courses [6] [11] [1]. For example, one study revealed a significant increase in engineering students' trait mindfulness, engagement in mindfulness outside of sessions, and intellectual curiosity and exploration after participating in a four-week mindfulness intervention [1]. The same study finds that the engineering students' grades on the selected ABET-relevant assignment were significantly, positively related to their self-reported preference for intellectual challenge and their ability to observe and experience academic-related experiences [1] mindfully.

Numerous studies also show that engineering students are receptive to practicing mindfulness (see [6] for a detailed review). The first author's (instructor's) experience through end-of-semester student reflections in her other classes and classroom observations strongly supports students' receptiveness to practice mindfulness in the classroom. It is worth noting that the instructor has been utilizing mindfulness activities in sophomore to senior-level civil engineering and fundamental mechanics courses for the past four years.

Mindfulness practices, innovation, and creativity: Cognition is all forms of knowing and awareness, such as perceiving, conceiving, remembering, reasoning, judging, imagining, and problem-solving [7]. A research study [18] in psychology revealed that brief mindfulness interventions in novices could improve mood, reduce fatigue and anxiety, and increase mindfulness. Most importantly, it has shown a significant improvement in visuospatial processing, working memory, and executive functioning in a group of 49 college students. Out of 49 students, 24 were assigned to the meditation and 25 to the control group in this study.

Research studies on the correlation between mindfulness practices and engineering students' innovation and creativity are slim. One study [1], as mentioned in the previous section, shows a significant increase in intellectual curiosity and exploration after 4-week of mindfulness intervention. Another study investigating state mindfulness and stress in first-year engineering design concluded that brief (about 5-minute) mindfulness-based intervention has no significant impact on stress levels during the design tasks [6]. In another study, a research question on how dispositional (trait) mindfulness relates to engineering innovation was explored with a larger group of engineering students and recent graduates [2]. The findings of this research show that engineering students with a highly mindful attitude (open, receptive, curious) tend to participate in learning experiences related to design and innovation [2].

Mindfulness practices and student focus and attention span: Focus and attention span are related: greater focus yields a longer attention span. The average length of attention span among college students is still being debated. It largely varies from person to person due to many factors, including personality. Research shows that regardless of age, students can stay focused on an important task only for a short period, typically three to five minutes before most students self-interrupt their studying to switch to another task [19]. Another research review points out that the most often cited source for a rapid decline in student attention during a lecture barely discusses student attention at all [20]. Another study concludes with no evidence from the literature about the concept of a 10-15 minute attention span [21]. Perhaps the most consistent finding of this review is that the most significant variability in student attention arises from differences between teachers and not from the teaching format itself [20]. Only a few studies

have been conducted on focus and attention span among engineering students. Even in psychology and psychiatry, research on the effects of brief mindfulness meditation on cognitive performance, such as attention span, is scarce and thus produces few reliable findings [22] [18]. However, there is evidence that brief (10 min) listening to mindfulness mediations can improve executive attentional control in novice meditators compared to a controlled activity [22]. Interestingly, this was most pronounced in individuals lower in neuroticism. Neuroticism is typically considered a tendency toward anxiety, depression, self-doubt, and other negative feelings [23].

The Study

This work-in-progress research study investigates the impact of short (3-5 minute) mindfulness practices on student attention and focus in an upper-level civil engineering design course. It is hoped that the results of this study will contribute to the growing body of knowledge in mindfulness and engineering education.

Participants and their backgrounds: Twenty-two upper-level undergraduate civil engineering students in the Structural Steel Design course (the entire class) taught by the first author were chosen for the study. Their ages range between 18-24 years. Twenty-one students (out of 22 total students) opted in to fill out the first demographics survey. Four students identified as female, and seventeen identified as male. The students were taking between 13 and 19 credits for the semester. Most students, eleven, reported a course load of 15 credits. The students reported their part-time employment status. Nine students out of twenty-one reported not being employed. Four students were employed more than 20 hours per week, and eight were employed less than 20 hours per week. All students in this population took the Structural Analysis course with the same instructor in the 2022 spring semester, in which they were first introduced to mindfulness activities in an engineering course. During the spring 2022 semester, mindfulness activities were not carried out in every class. However, when mindfulness practices occurred, the selected practices included short (3-5 minute) mindfulness activities such as listening, body awareness, lovingkindness, and yoga at least once a week. Students in the course were invited to keep a journal to record their experiences inside and outside class. They could also submit an optional half-page self-reflection at the end of the semester. One student from this group reported a daily mindfulness practice in the demographic survey in the current study.

About the Course: Structural Steel Design is one of the five listed design electives civil engineering students must choose from to fulfill their degree requirements in the fourth year. This course consisted of a group design project, six homework assignments, and four reading quizzes during the fall of 2022. The course is a designated project-based and active learning course by the college. Students were led through a review of reading assignments, case studies, and example problems in each lecture period, with opportunities to pause, reflect, and comment on what they have learned. Students often worked in small groups during class. Physical models were used to demonstrate key concepts, and new topics were grounded in real-world examples and case studies.

Consent process: The study received Institutional Review Board (IRB) approval from the university before collecting the data. All students had the choice to participate in any research-associated surveys. All survey data will be de-identified by the co-author of this paper, who is a

member of the Center for Teaching and Learning staff. Students were provided a research information sheet to decide whether to participate, and the information was also included in the syllabus. For fairness for all students and as required by IRB, students who chose not to participate were asked to generate a question by reviewing their notes from the previous lecture or attempting a problem in their current homework. Following the mindfulness session, the instructor would answer two of these questions before introducing the new topics for the class period.

Method

Class activities and data collection: The class schedule was 9:40 to 10:30 am on Monday, Wednesday, and Friday for 15 weeks. Each class started with a mindfulness activity. These activities include mindful breathing, awareness, observation, listening, yoga, and meditations like lovingkindness and gratitude. Most of these short (3-minute) meditations, labeled 'Quickies,' were adopted from the UVM Mindfulness Program [24]. On Fridays, students were exposed to other contemplative learning activities (5-7 minutes) aimed at developing a deeper awareness of self and others. These activities, labeled 'Nuggets of Wisdom,' included reflective writing, deep listening, insight mediations, and mindful conversations. See Appendix A for examples. Qualitative and quantitative data were gathered from (i) weekly surveys, (ii) SFG interviews, (iii) instructor's journal reflections and observations, and (iv) students' performance in the course. This WIP paper utilizes data from (i), (ii), and (iii). Survey data was collected starting the 10^{th} week of classes. A total of 5 weekly surveys administered anonymously using Qualtrics were sent between Oct. 31 and Dec. 5. Twenty-two students (the entire class population) were invited, and 21 students participated and completed the demographic survey. The weekly surveys had between 9 and 15 respondents, except for the final survey during the last week of the class. The final survey had five respondents. The demographic survey consisted of 11 questions related to gender identification, age, grades in two prerequisite courses, employment status, and questions about daily mindfulness practice. See Appendix C for the complete list of questions. The weekly surveys had questions on (i) the specific mindfulness activity they participated in class and (ii) a self-mindfulness survey using the FMI. FMI was specifically chosen due to its simplicity and reputation as a valid and reliable tool to measure state mindfulness in novices [4, 5]. Students were asked to use the past seven days as a time frame to answer 14 questions in the survey.

Student focus group (SFG) interviews: In addition to the weekly surveys, students were invited to participate in SFGs led by the university's Center for Teaching and Learning (CTL) SFG leaders. The student leaders prepared the interview questions after a conversation with the instructor. Modifications to the agreed-upon questions were then reviewed and approved by the IRB before running the focus groups with the students (see Appendix D for focus group questions). Three focus groups were conducted consisting of a total of 9 students. The focus groups aimed to capture students' overall experience of the mindfulness activities. During these interviews, students were given the opportunity to express their unbiased experience along with any benefits they gained and challenges they faced. The interviews were recorded and transcribed using *NVivo*, a qualitative data analysis tool. SFG leaders then identified general themes/sub-themes in the transcripts. In their final report, the results were written only according to themes, with deidentified quotes to retain confidentiality.

Measures of Mindfulness: The FMI survey was used to measure mindfulness and presence (attention to the present moment) in this study (see Appendix B for FMI survey questions)[4, 25]. Readers are referred to [26] and [27] for comprehensive analysis and validation of the current *state* and *trait* mindfulness measures, respectively. In addition to the FMI, two questions were included to measure students' focus: *(i) After today's mindfulness activity, I felt? (very focused/focused/no different/less focused/much less focused)* and (ii) *Please write your reflection on today's in-class mindfulness activity: (elaborate on your experience related to question (i)).* A third response question was added to measure students' overall attention in class, attention span, focus, and performance: *Describe your feelings about your overall in-class performance after the mindfulness activity in class today.*
Additionally, results from the SFG report are used to measure mindfulness, attention span, focus, and performance. Students' performance data linking to the survey results are not used for this WIP paper.

Results and Discussion

Overall mindfulness: As mentioned before, the aggregated weekly survey data collected over five weeks and the SFG final report are discussed in this WIP research paper. Numerical responses of all FMI survey questions combined (question 13 reverse-coded) are given in Figure 1. This provides a snapshot of students' overall mindfulness over five weeks of the course. As seen, classroom mindfulness practices have positively impacted students' self-reported state of mindfulness. The total percentages of 'fairly often' and 'almost always' showed an upward trend, with an increase from 54% on Oct. 31 to 67% on Dec. 5, revealing an overall improvement in mindfulness.

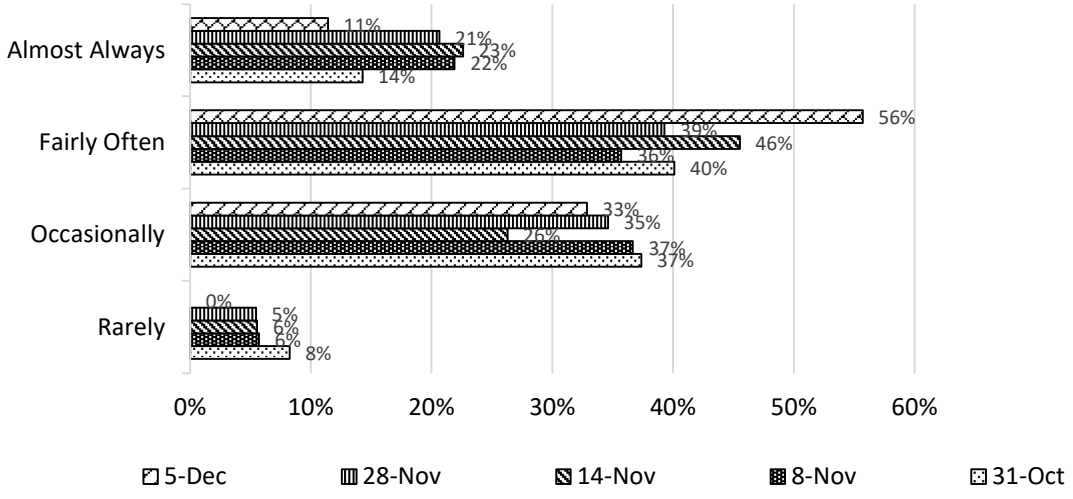

Figure 1: Change in students' **overall mindfulness** over five weeks of the course.
(Responses to all FMI questions with Q13 reverse-coded, combined)

The SFG data reported that students identified the mindfulness practices as (i) internal (imagine or visualize something or reflect on a podcast) and (ii) physical (breathing and body awareness) and shared their experience on each of the two categories as follows [28].

"And I just thought, you know, her showing us that knowledge of like kind of visualizing in your head and the power that has, I found that pretty interesting."

"…prior to practicing mindfulness… I didn't really realize that you're breathing can be manual and being able to manipulate the breathing can really impact your mental psyche and metaphysical feeling."

Students also reported that mindfulness practices created a classroom environment where they felt supported by their professor. Most students described feeling more confident, engaged, and satisfied with their learning experience in the steel design course [28].

When asked about the benefits of mindfulness inside and outside the classroom, many felt that having time at the beginning of class to relax impacted their stress levels, motivation, and ability to focus [28].

Some students shared how mindfulness impacted their daily lives and academics, as quoted below.

"[while] skiing which is kind of funny. Like, if I'm really cold on the chair lift it kind of helps me to not focus on how cold I am, so, that's gotten me through some painful lift rides, which is kinda nice. It takes my mind off of things I guess."

"definitely like the breathing. Yeah, she's posted some links on Blackboard; I'm going through her website… if I'm studying for a test… and just listen in on one of those before I started studying" A student response from the SFG interview on the benefits of mindfulness outside the classroom.

On the SFG exit survey (see Appendix D), students rated comparatively high, average (0-4 scale) = 2.89 for question 3 (*These mindfulness practices positively impact my **effort** in CE 172*) and an average = 2.67 for question 4 *(These mindfulness practices positively impact my **engagement** in CE 172).* The lowest rating, average = 2.0, was given for question 2 (*These mindfulness practices positively impact my **grades** in CE 172*).

Presence: The presence is the attention to the present moment. Questions 1,2,3,5,7, and 10 of the FMI are used to measure presence and attention [25] in this study. The results plotted in Figure 2 show an improvement in students' ability to stay in the present moment over time. It is worth noting a 10% decrease in the percentages of 'Almost Always' from Nov. 28 to Dec. 5, data in Figure 2. This may be attributed to higher stress levels during the exam period of the semester (Dec. 10^{th} -16^{th}).

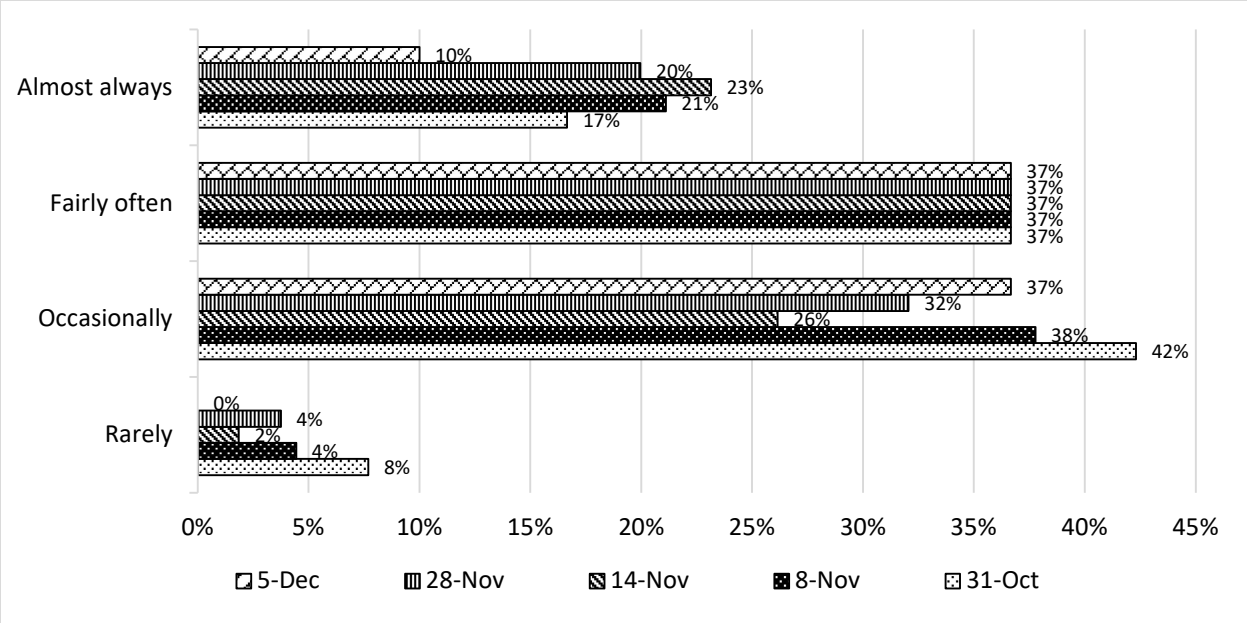

Figure 2: Change in students' attention and **presence** over five weeks of the course.
(Responses to the FMI questions 1,2,3,5,7 &10, combined)

Focus: Figure 3 shows total student responses to the question, *"After today's mindfulness activity, I felt?"*. As seen a significant improvement in students' focus was apparent as the semester progressed. The following quotes from weekly surveys provide further evidence.

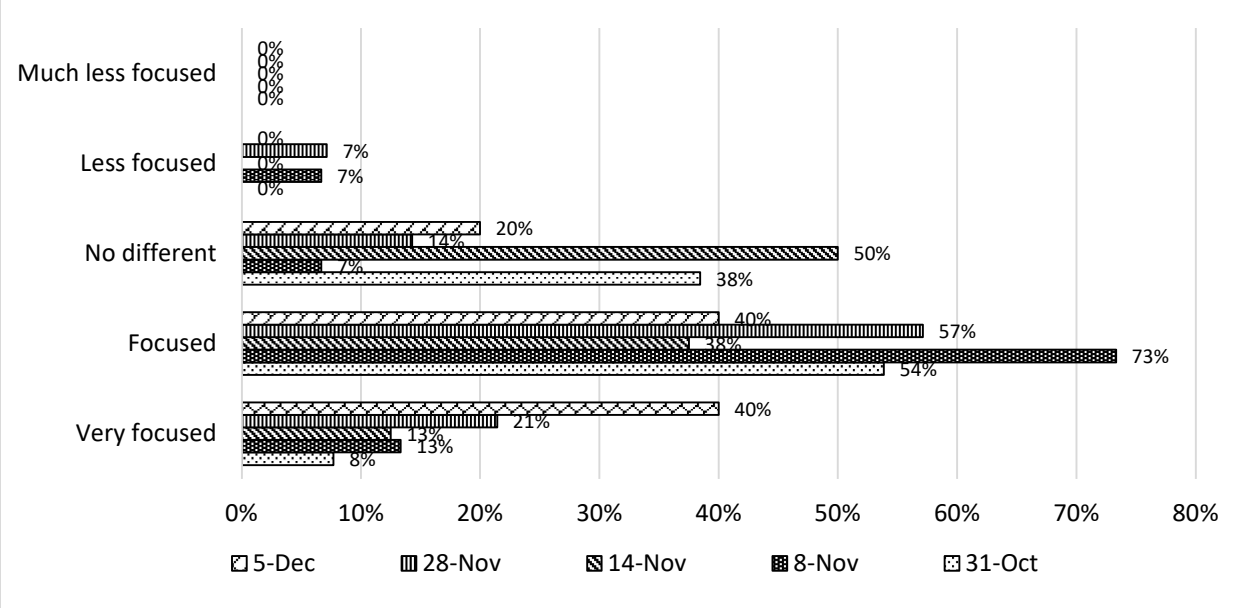

Figure 3: Change in students' **focus** over five weeks of the course.
(Responses to the weekly survey question, *"After today's mindfulness activity, I felt?"*)

In response to reflecting on the in-class mindfulness activity, students wrote the following to elaborate on the feeling of being focused.

"I'm typically kinda tired when I get to class, and I think the mindfulness activity helps me focus for the duration of the class." Student response from Oct. 31 stating they felt "focused.'

"Helps me move away from general burden of stress I carry with me." A student response from Oct. 31 stating they felt very focused.

"This activity helped me focus during class because I was feeling impatient and tired." A student response from Nov. 8 stating they felt focused.

"Dissociated myself from my thought process and then returned by refocusing on elements around me." A student response from the Oct. 31 survey stating they felt focused.

"Today I enjoyed our mindfulness activity, mainly because it was longer than usual and it was different from the previous exercises. this allowed me to properly ground myself before the class." A student response from the Nov. 8 survey stating they felt focused.
Interestingly, students participated in gratitude mindfulness meditation on Nov. 8.

"Today I have a rather busy day of classes and labs so I wasn't in the most relaxed and focused mindset. However, the mindfulness let me relax and get in the moment for class to learn and participate." A student response from the Nov. 28 survey stating they felt focused.

Attitude and Acceptance: The third key component of mindfulness is attitude. As defined earlier in the paper, attitude is one's ability to observe thoughts non-judgmentally with an attitude of kindness and curiosity. Acceptance is a favorable attitude toward an idea, situation, person, or group [7]. Students' change in attitude over time was measured by measuring the acceptance through FMI questions 4,6,8,9,11,12,13, and 14 (recommended by [25]). The study found that students' combined responses to 'fairly often' and 'almost always' for those FMI questions increased from 57% (Oct. 31) to 71% (Dec. 5) (see Figure 4).

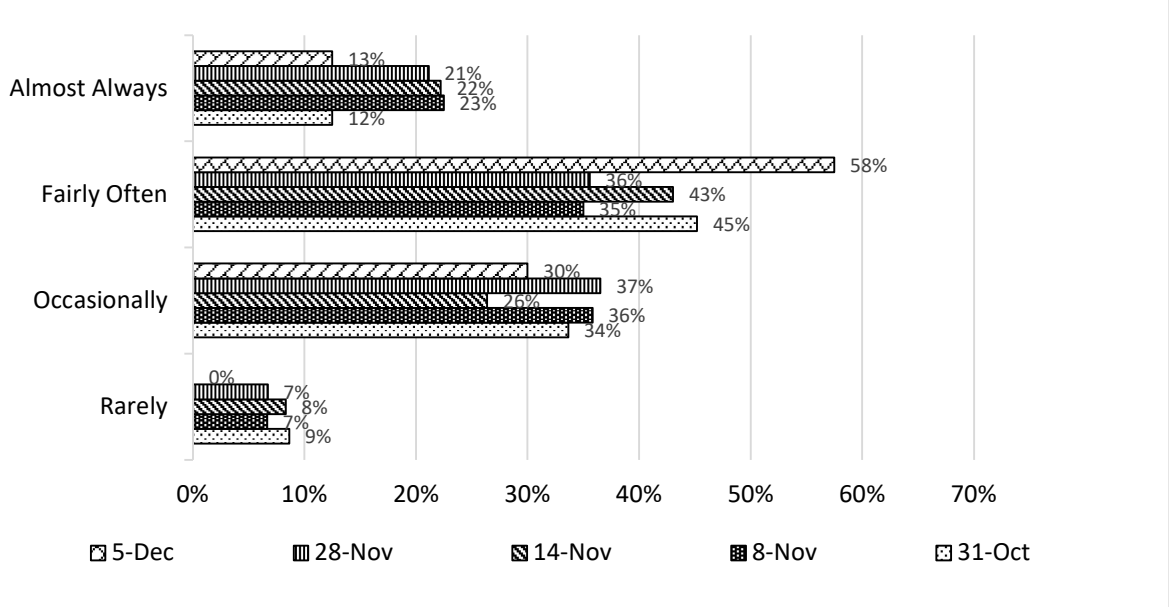

Figure 4: Change in students' **acceptance** over five weeks of the course.
(responses to FMI questions 4,6,8,9,11,12,13, and 14, combined)

Professor-student relationship: An interesting outcome, not planned in the study, emerged as a common theme in the SFG report. Many indicated that practicing mindfulness with the professor positively impacted their perceived professor-student relationship, and they felt that the professor cared about their well-being [28]. The following two quotes are taken from the SFG report.

"… you see that taking that time for them is as beneficial as it is for us. So, I think it's just once again goes to show that you know, I guess it builds a community."

"…the general attitude of our professor towards us as like people, not just as students, is much more holistic and respectful and acknowledging of you know that we are people, and that we're not just, you know, engineering students."

Classroom implementation of mindfulness: Implementation is another theme that emerged in the SFG report. Students felt that the class schedule affected the benefits of mindfulness, indicating that they preferred mindfulness practices in 75-minute classes instead of 50-min classes. They also suggested consistency in certain practices (most-liked) and better organization of the practices. It is worth mentioning that when asked about implementing mindfulness practices in other classes, students had mixed opinions [28] (see below).

"I think I would definitely support it there being like a just across the board, you know, professors want to include mindfulness, and they can have the opportunity to do so. And I think also some professors it might not work for them. It might not work for the class… it depends on the professor... I think (instructor's name) has a lot of experience and it's very helpful for her to kind of guide us and direct us in some way. I don't see the same for other professors, not that they are not capable of it. I think just maybe it is not relatively new, but I think it's very popular right now."

Conclusions, Limitations, and Future Work

The aggregate results from the surveys show promising upward trends in students' overall mindfulness, attention, focus, and acceptance. Instructor's observations and students' written responses show their receptiveness to practice mindfulness in class, agreeing with similar findings by other scholars on engineering students [1, 6].
Students also reported that practicing mindfulness in class positively impacted their relationship with the professor. Additionally, they preferred the practices implemented in longer class periods (75-min) than shorter (50-min) class periods [28].

The instructor's observations and journal records indicated higher student attention and focus levels throughout the course compared to previous years. She also observed and learned that the majority of the students prefer loving-kindness and gratitude practices and listening meditations over breath awareness practices. Some students mentioned that focused attention practices such as breath meditation stir up their mind wandering, especially during the midterms and finals.

Limitations of the study include a smaller sample size (n=21), lower response rates in some weekly surveys, voluntary participation in surveys and focus groups, and lack of a control group. Additionally, the data was gathered the 10th week into the semester, but practices started in the first week of classes. Students' prior mindfulness experience with the same instructor in the spring 2022 structural analysis course may be a limitation (see under the 'participants and their backgrounds'). For this WIP paper, only self-reported measures are used. Similar to any qualitative research, open-ended questions have their limitations.

Future work on the study will address some of the above limitations. By analyzing the individual student performance, the researchers will be able to dive deeper into the research question and identify additional factors and relationships associated with mindfulness in civil engineering students. Authors may be able to capture any underlying relationships between mindfulness and student grades by de-identifying and linking the course grades to the survey results.

The research is being continued with the same group of students and the instructor in the spring of 2023. Since most of these students are expected to graduate in the spring of 2023, researchers are curious to investigate any change in their state mindfulness and mindfulness practices as they have advanced in the civil engineering program. A few additional questions are included in the new weekly survey to learn about students' preferences for different types of mindfulness activities, specifically, the activities called 'Nuggets of Wisdom.' Why they chose certain practices over others and their intention to continue mindfulness practices after the course and graduation would be investigated.

The research will be further expanded to another upper-level civil engineering design course with a different instructor in the fall semester. Planning is also underway to broaden this study to other disciplines, such as chemistry, health sciences, and social work. The impact of mindfulness practices on civil engineering students (and other engineering students, for that matter) can be identified more explicitly by investigating diverse fields.

Acknowledgments:

This Scholarship of Teaching and Learning (SoTL) study was supported by the University of Vermont's Center for Teaching and Learning (CTL). Authors would like to convey special thanks to their colleagues: Wendy Verrei-Berenback, Lizzy Pope, Laura Hill, Kristen Andrews, John Lens, and others in the Contemplative Practices Learning Community, graduate student Maddy Pimental and along with all the undergraduate student focus group leaders: Sachi Sakaniwa, Zoe Schlosser, Maja Paulk, River Bond, and student participants of the Structural Steel Design course.

References:

[1] T. Estrada and E. Dalton, "Impact of Student Mindfulness Facets on Engineering Education Outcomes: An Initial Exploration," *ASEE Annual Conference & Exposition, Tampa, FL, USA, June 15, 2019.*

[2] B. Rieken, M. Schar, S. Shapiro, S. Gilmartin, and S. Sheppard, "Exploring the relationship between mindfulness and innovation in engineering students," in *Proceedings of the American Society for Engineering Education Annual Conference, June 25-28. Columbus, OH.*, 2017.

[3] M. V. Huerta, A. R. Carberry, T. Pipe, and A. F. McKenna, "Inner engineering: Evaluating the utility of mindfulness training to cultivate intrapersonal and interpersonal competencies among first-year engineering students," *Journal of Engineering Education,* vol. 110, no. 3, pp. 636-670, 2021.

[4] H. Walach, N. Buchheld, V. Buttenmuller, N. Kleinknecht, and S. Schmidt, "Measuring mindfulness - the Freiburg Mindfulness Inventory (FMI)," (in English), *Personality and Individual Differences,* Article vol. 40, no. 8, pp. 1543-1555, Jun 2006.

[5] N. Kohls, S. Sauer, and H. Walach, "Facets of mindfulness – Results of an online study investigating the Freiburg mindfulness inventory," *Personality and Individual Differences,* vol. 46, no. 2, pp. 224-230, 2009.

[6] H. Nolte, J. Huff, and C. McComb, "No time for that? An investigation of mindfulness and stress in first-year engineering design," *Design Science,* vol. 8, 2022.

[7] American Psychology Association, "APA Dictionary of Psychology Online," https://dictionary.apa.org/ (accessed April 14, 2023).

[8] S. L. Shapiro, *Rewire your mind : discover the science + practice of mindfulness*. London: Aster (in English), 2020, pp. xiii, 231 pages.

[9] S. L. Shapiro and L. E. Carlson, *The art and science of mindfulness: Integrating mindfulness into psychology and the helping professions*. 2009.

[10] K. W. Brown and S. Cordon, "Toward a Phenomenology of Mindfulness: Subjective Experience and Emotional Correlates," in *Clinical Handbook of Mindfulness*, F. Didonna Ed. New York, NY: Springer New York, 2009, pp. 59-81.

[11] M. D. Bamber and J. Kraenzle Schneider, "Mindfulness-based meditation to decrease stress and anxiety in college students: A narrative synthesis of the research," *Educational Research Review,* vol. 18, pp. 1-32, 2016.

[12] A. MacDonald, "A Harvard Medical School Special Health Report," in "Positive Psychology: Harnessing the power of happiness, mindfulness, and inner strength," Harvard Medical School, 2019.

[13] S. R. Bishop *et al.*, "Mindfulness: A Proposed Operational Definition," *Clinical psychology (New York, N.Y.),* vol. 11, no. 3, pp. 230-241, 2004.

[14] M. Fujino, Y. Ueda, H. Mizuhara, J. Saiki, and M. Nomura, "Open monitoring meditation reduces the involvement of brain regions related to memory function," *Scientific reports,* vol. 8, no. 1, p. 9968, 2018.

[15] D. B. Bellinger, M. S. DeCaro, and P. A. Ralston, "Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom," *Conscious Cogn,* vol. 37, pp. 123-32, Dec 2015.

[16] B. Rieken, M. Schar, and S. Sheppard, "Trait mindfulness in an engineering classroom: An exploration of the relationship between mindfulness, academic skills, and professional skills," in *2016 IEEE Frontiers in Education Conference (FIE)*, 12-15 Oct. 2016. pp. 1-8.
[17] E. E. McBride and J. M. Greeson, "Mindfulness, cognitive functioning, and academic achievement in college students:the mediating role of stress," *Current Psychology,* pp. 1-11, 2021.
[18] F. Zeidan, S. K. Johnson, B. J. Diamond, Z. David, and P. Goolkasian, "Mindfulness meditation improves cognition: Evidence of brief mental training," *Consciousness and cognition,* vol. 19, no. 2, pp. 597-605, 2010.
[19] A. Gazzaley and L. D. Rosen, *The distracted mind: Ancient brains in a high-tech world*. MIT Press, 2016.
[20] N. A. Bradbury, "Attention span during lectures: 8 seconds, 10 minutes, or more?," ed: American Physiological Society Bethesda, MD, 2016.
[21] K. Wilson and J. H. Korn, "Attention during lectures: Beyond ten minutes," *Teaching of Psychology,* vol. 34, no. 2, pp. 85-89, 2007.
[22] C. J. Norris, D. Creem, R. Hendler, and H. Kober, "Brief mindfulness meditation improves attention in novices: Evidence from ERPs and moderation by neuroticism," *Frontiers in human neuroscience,* p. 315, 2018.
[23] Sussex Publishers, LLC. "Psychology Today." psychologytoday.com. https://www.psychologytoday.com/us/basics/neuroticism (accessed April 14, 2023).
[24] UVM. "Center for Health and Wellbeing at UVM, UVM Mindfulness." https://www.uvm.edu/health/mindfulness (accessed April 14, 2023).
[25] P. Malinowski. "Freiburg Mindfulness Inventory (FMI)." Meditation Research. https://meditation-research.org.uk/knowledge/freiburg-mindfulness-inventory-fmi/ (accessed April 14, 2023).
[26] G. Tanay and A. Bernstein, "State Mindfulness Scale (SMS): development and initial validation," *Psychological Assessment,* vol. 25, no. 4, p. 1286, 2013.
[27] A. Siegling and K. Petrides, "Measures of trait mindfulness: Convergent validity, shared dimensionality, and linkages to the five-factor model," *Frontiers in psychology,* vol. 5, p. 1164, 2014.
[28] CTL, "CE 172 SoTL Student Focus Group Results Report," University of Vermont, unpublished.
[29] S. Harris, "Waking Up." wakingup.com. https://www.wakingup.com/ (accessed April 14, 2023).
[30] D. P. Barbezat, M. Bush, and P. J. Palmer, *Contemplative Practices in Higher Education: Powerful Methods to Transform Teaching and Learning*. John Wiley & Sons, 2013.
[31] A. Lightman, *Einstein's Dreams*. Vintage, 2011.

Appendix A:

Examples of mindfulness activities:

The specific mindfulness activities on the days when the surveys were sent out are given below:
Oct. 31: Anchor externally (2 minutes) [24]
Nov. 8: Gratitude meditation (3 minutes) [24]
Nov. 14: Listening meditation (3 minutes) [24]
Nov. 28: A poem 'Silence' by David Whyte from the Waking Up App (3.5 min) [29]
Dec. 5: Body awareness meditation (3 min) [24]

Example of sound meditation [30]:
Mindfulness Instructions:
"Begin by sitting in a chair or on a cushion on the floor, with your back straight. Either close your eyes or rest them with a soft gaze on a point nearby. Relax into your sitting posture with a few deep breaths. Allow the body and mind to become utterly relaxed while remaining very alert. Sweep your awareness through your body, feeling the sensations with no agenda, no goal, just staying mindful of these sensations.
After some time, shift your awareness to the sounds that you hear. Be aware of both the pure sound vibration and the space or silence between the sounds. As with body sensations, incline your awareness away from the definition of the sound, or thoughts about the sound, and simply attune to the sound just as it is.
After some minutes of awareness of body and sounds, bring your attention to your natural breathing process. Locate the area where the breath is most clear, and let awareness lightly rest there. For some, it is the sensation of the rising and falling of the abdomen. For others, it may be the sensations experienced at the nostrils with the inhalation and exhalation.
Let the breath breathe itself without control, direction, or force. Feel the full breath cycle from the beginning through the middle to the end.
The awareness is a combination of receptivity, like listening, and alert, attentive presence. Let go of everything else, or let it be in the background. Just let the breathing breathe itself. As soon as you notice the mind wandering off, lost in thought, be aware of that without judging, and gently return again to your breath." [30]

An example of 'Nuggets of Wisdom' practices:
One student reads a chapter (about 2 pages) from the novel *Einstein's Dreams* [31]. The rest of the students listen quietly and then discuss their thoughts and feelings and take away message from what they've heard.
"Jun. 3 1905
Imagine a world in which people live just one day. Either the rate of heartbeats and breathing is speeded up so that an entire lifetime is compressed to the space of one turn of the earth on its axis – or the rotation of the earth is slowed to such a low gear that one complete revolution occupies a whole human lifetime…."

Appendix B:

Freiburg Mindfulness Inventory [4]:
The purpose of this inventory is to characterize your experience of mindfulness. Please use the last seven days as the time-frame to consider each item. Provide an answer for every statement as best you can. Please answer as honestly and spontaneously as possible. There are neither 'right' nor 'wrong' answers, nor 'good' or 'bad' responses. What is important to us is your own personal experience.

1 = Rarely, 2 = Occasionally, 3 = Fairly often, 4 = Almost always

1. I am open to the experience of the present moment.
2. I sense my body, whether eating, cooking, cleaning or talking.
3. When I notice an absence of mind, I gently return to the experience of the here and now.
4. I am able to appreciate myself.
5. I pay attention to what's behind my actions.
6. I see my mistakes and difficulties without judging them.
7. I feel connected to my experience in the here-and-now.
8. I accept unpleasant experiences.
9. I am friendly to myself when things go wrong.

10. I watch my feelings without getting lost in them.
11. In difficult situations, I can pause without immediately reacting.
12. I experience moments of inner peace and ease, even when things get hectic and stressful.
13. I am impatient with myself and with others.
14. I am able to smile when I notice how I sometimes make life difficult.

Appendix C:

Demographic Survey questions:

1. Fill in your email
2. What is your gender? (Male/Female/Non-binary/Gender Fluid/Other)
3. What is your age? (Under 18/18-24/25-34/35-44)
4. What was your grade in CE170: Structural Analysis? (A/B/C/D)
5. What was your grade in CE100: Mechanics of Materials? (A/B/C/D)
6. How many credits are you taking right now?
7. What is your current part-time employment status? (Employed part-time (more than 20 hours)/Employed part-time (less than 20 hours)/Not Employed)
7. Do you work on campus? (Yes/No)
8. Do you have a daily mindfulness practice? (Yes – branches to additional questions/No)

If yes: additional questions:

- What type of mindfulness do you do daily? (Seated meditation/Breathing exercise/Journaling/Other - Fill in box)

9. Have you ever participated in a mindfulness retreat? (Yes/No)
    - How long was the retreat? (Half a day/Full day/Overnight/Other -Fill in box)
    - What kind of activities did you do at the mindfulness retreat?
    - When did you attend the most recent mindfulness retreat you attended? Month and Year?

Weekly Survey questions:

1. Please Enter your ID number
2. After today's mindfulness activity, I felt?
3. Please write your reflection on today's in-class mindfulness activity: (elaborate on your experience related to question 2).
4. Describe your feelings about your overall in-class performance after the mindfulness activity in class today: open-ended response.
5. The full Freiburg Mindfulness Inventory (See Appendix B)

Appendix D:

Student Focus Group Interview Questions and Exit Survey:

1. What were your experiences with mindfulness prior to this class?
2. You had the option to participate in the practices; why did you choose to do so or not?
3. In what ways did mindfulness practices affect your mood?
4. Are there areas of your life, academic or otherwise, where you see impacts of mindfulness?
5. How have mindfulness practices affected the classroom environment?
6. Have you noticed a difference in your interactions with your peers and/or professors as a result of the practices?
7. Is there a particular mindfulness practice that stood out to you?
8. How have these mindfulness practices affected your stress level?
9. Do you feel a difference between the Monday and Wednesday practices and the Friday practices? If so, please describe.
10. If you are journaling, is it helping you to process or make meaning of the mindfulness practices?
11. Do you have any other feedback about the mindfulness practices? Regarding delivery, approach, etc.?
12. Would you like to see these mindfulness practices implemented in other classes?

Exit Survey:

Before leaving, students were asked to complete this short exit survey:

Please rate the degree to which you agree/disagree with the following statements:

1. These mindfulness practices positively impact my confidence in CE 172.
   (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
2. These mindfulness practices positively impact my grades in CE 172.
   (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
3. These mindfulness practices positively impact my effort in CE 172.
   (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
4. These mindfulness practices positively impact my engagement in CE 172.
   (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)
5. These mindfulness practices positively impact my satisfaction with CE 172.
   (Strongly Disagree/Disagree/Neutral/Agree/Strongly Agree)