From Mind Full to Mindful: Proposing Mindfulness as a Proactive Strategy for Safeguarding Mental Health in Engineering Education.

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Abstract

Engineering students are increasingly reporting struggles with stress and mental health challenges during their undergraduate careers, yet most will only consider seeking support once they have reached a significant state of distress. While university campuses are increasingly establishing mental well-being centers and support structures for students, these efforts are reactionary and require student engagement outside the classroom. Mindfulness, a well-recognized mental health intervention, has shown significant promise as a preventive strategy that fosters a culture that prioritizes well-being in educational settings. This intervention offers many benefits for students beyond mental health, including improved focus, emotional regulation, stress reduction, enhanced cognitive performance, and overall well-being. Despite the growing need for such interventions, the adoption of mindfulness as a practice in engineering education remains limited. This paper proposes mindfulness as a proactive strategy for safeguarding students' mental health in engineering education. Specifically, we draw from existing literature to dive into the benefits and potential feasibility of incorporating mindfulness into daily engineering curricula. By equipping engineering students to manage stress, we can better promote their overall well-being as students and as emerging career professionals, aiming to foster healthier engineering communities and workplace environments.

Introduction

The rapid pace of today's world often leaves people feeling burnt-out and struggling to adapt, leading to an increase in mental health concerns [1]. Developing skills that promote physical and mental well-being is crucial for helping individuals thrive in this fast-paced environment. Mounting concerns over college students' mental health have gained significant national attention, with mental health issues increasing over 60% during 2020-2021, as reported by the Healthy Minds Study [2]. Reports of mental health issues are similarly growing in the field of engineering education, which is notorious for challenging content and intense coursework. Current solutions focus on reactive measures, such as counseling and therapy centers; however, these university-provided supports require students to manage and navigate help-seeking outside of the classroom while completing coursework and other responsibilities. Therefore, wellness support in the classroom may serve as an essential and effective mechanism for proactively safeguarding students' mental health by ensuring equal access to and engagement in support for all students. Positioning mental health and well-being alongside technical course content in the classroom demonstrates its value in both academia and industry.

Mindfulness is a well-recognized mental health intervention with significant promise as a preventive strategy for promoting well-being. Mindfulness, originating from Asia and now widely embraced globally, holds numerous definitions owing to its diverse cultural roots. Each country or culture offers distinct perspectives on mindfulness, making an exact definition challenging and contingent on the context of its application. Amidst this diversity, common threads intersect across all definitions regardless of origin. Zen master Thich Nhat Hanh, a revered Buddhist figure, activist, and educator, defines mindfulness as "showing us what is

happening in our bodies, emotions, minds, and the world. Through mindfulness, we avoid harming ourselves and others" [3]. Another widely recognized definition comes from Kabat-Zinn, who frames mindfulness as "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally" [4]. This definition emphasizes the intentional and non-judgmental aspects of mindfulness while highlighting its focused engagement with the present. Overall, mindfulness involves noticing and acknowledging thoughts, feelings, and sensations as they arise in real-time. Instead of reacting automatically to situations, mindfulness encourages a pause to observe and accept each moment, promoting a more thoughtful and centered approach to life.

Within engineering education, several cultural characteristics have been attributed to students' limited help-seeking behavior. Prevailing ideas of a "meritocracy of difficulty" [5] and a "work hard, play hard" mindset [6] [7] that commend relentless dedication to coursework at the expense of other life necessities such as sleep, with the rationale being that undergraduate engineering programs are relatively short in duration; the sacrifice of physical and mental health for a short period of time is justified by the high salaries and other materialistic possessions that students anticipate receiving upon entering the workforce. At the same time, help-seeking behavior is considered a sign of weakness or failure [5]. Many students who were considered high performers during high school must now navigate their undergraduate program as mediocre performers and often experience significant challenges in learning how to study [8]. Such environments may be particularly challenging for students [9], especially among those belonging to minoritized and marginalized groups. To support national efforts to diversify the engineering workforce, it is even more critical to create supportive and healthy learning environments that benefit entire student communities. The need for such support has been explicated by many engineering students. One of these students includes Sophie, an undergraduate engineering student who, when asked what she would change about engineering education if she could, stated,

> The university faces a mental health issue with a limited number of counselors. However, instead of addressing the root cause of the problem, they are focusing on addressing one of its symptoms. One way universities can support their students is by creating a learning policy that supports those who may be going through a difficult time but are uncomfortable discussing it. This way, students can have a cushion to fall back on [10].

Literature on implementing mindfulness in engineering education is still emerging. Therefore, we focus this paper on presenting findings of a narrative literature review to suggest mindfulness as a proactive way to protect one's mental health in engineering education. We conclude this work by discussing potential challenges and recommendations for future research aimed at integrating mindfulness into engineering curricula. To frame our work within the context of engineering education literature, the following research questions guide our exploration: (1) Why do engineering students need mindfulness, and (2) What are the potential challenges that arise in applying mindfulness to engineering education?

Literature Review Techniques

To address our research questions, we started with two sets of keywords. The first set included "mindfulness definition," "mindfulness practices," "mindfulness benefits," and "engineering students," which yielded six articles. To broaden our understanding, we extended the search to include mindfulness in the larger context of education, resulting in a total of 43 articles. We then filtered out duplicates, non-English language articles, and those that could not be transferred to engineering education. Overall, the application of our inclusion criteria resulted in the identification of 16 relevant articles. In the second set, we used a search string that included "mental health", "challenges", "barrier", and "engineering students," which led to the identification of 14 articles. In total, we reviewed 30 articles to better understand the state of mindfulness research conducted in the engineering education literature and, from there, discerned the alignment of mindfulness benefits with the specific needs of engineering students. This existing body of work will help us identify disconnects and develop strategies to bridge these gaps. In the following sections, we delve into the results of our literature review by discussing literature that connects mindfulness practices to the unique demands of engineering education. We frame our discussion as answers to our posed research questions.

Research Question 1: Why do engineering students need mindfulness?

In response to our first research question, the literature clustered around three significant topics: (1) to be aware of and actively manage stress, (2) to reinforce the importance and development of professional skills, and (3) to enhance academic outcomes. Each answer is further described in the following sections.

To Be Aware of and Actively Manage Stress

Recently, educational institutions have observed a significant rise in mental well-being support offerings, underscoring a growing acknowledgment of preserving one's mental wellness at the postsecondary level [11]. However, a pressing concern remains—many students, particularly those in engineering, seek assistance only when issues become glaringly apparent, leading to reactive rather than proactive treatment [9]. Studies indicate that engineering students face higher stress levels, putting them at significant risk of mental illness compared to the general population [12][13][14]. With inherent time and effort requirements, this reactive approach poses challenges for achieving effective healing. High-stress levels not only negatively impact academics but also contribute to additional mental health challenges and physical illnesses [15]. Addressing the high prevalence of stress and mental health concerns among undergraduate engineering students is increasingly imperative [16].

There is a commonly held belief that engineering education is inherently stressful [15]. This belief contributes to a lack of support-seeking behaviors and can even lead to students leaving engineering programs due to the perceived unmanageability of stress, anxiety, and belonging. Studies have shown that feeling a lack of belonging in engineering programs can be a top reason for students to leave [17]. Chen [18] found that between 2003 and 2009, almost half (41%) of bachelor's degree students who started studying engineering discontinued their pursuit of the field. The reasons varied, with 21% switching to non-STEM majors and 20% dropping out of

college without obtaining any degree or certificate. Students often face challenges when seeking help for mental health issues due to physical barriers such as their immediate environment, schedule constraints, limited access to resources, and uncertainty about when they'll need help [19]. Many students see seeking help as an additional task that adds to their already overloaded schedules, making it challenging to find time for self-care.

Managing stress can be seen as a challenge that requires problem-solving skills, which aligns with the engineering mindset. Instead of just trying to reduce stress, a better approach is to reframe it as a manageable challenge inherent in problem-solving. Mindfulness practices help in this regard by allowing individuals to understand their emotional and cognitive responses to stressors [20]. This helps students to focus on problem-solving rather than feeling overwhelmed. Practicing non-judgment for oneself and the external world helps accept reality, heal, and learn from mistakes. Mindfulness is associated with distinct neural responses that support maintaining emotional equilibrium and reduce symptoms of depression [21].

Mindfulness practices, such as mindful breathing, Observing-Thoughts Meditation, and Mindfulness-Based Stress Reduction (MBSR), have effectively boosted adaptability and resilience, improving mental health outcomes [22]. Mindful breathing has been shown to effectively reduce levels of stress, depression, and anxiety [23]. This technique has been studied extensively and has been shown to significantly reduce stress, depression, and anxiety scores among university students. This highlights its potential as a nonpharmacological method that can be practiced virtually anywhere, even in the classroom. Observing-Thought Meditation is a core component of mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR). Both techniques are effective in managing depression, anxiety, and stress [22]. In fact, studies have shown that MBSR can significantly impact stress reduction and mental health improvement [24]. For example, a meta-analysis highlighted the efficacy of breathwork, a component of MBSR, in reducing stress and improving overall mental health. Similarly, a study conducted by Harvard researchers found that mindfulness meditation, integral to MBCT, changed brain activity in depressed patients by lessening the impact of brain patterns associated with depression [25].

To Reinforce The Importance and Development of Professional Skills

Engineers' roles in solving pressing global challenges have never been more critical as the world becomes increasingly complex. However, more than technical expertise is needed to address these challenges effectively. Engineers must also possess a wide range of professional skills that enable them to work collaboratively, communicate effectively, and navigate complex social contexts [26]. This is where mindfulness emerges as a transformative force in engineering education, promoting a holistic approach to the development of engineers. By fostering self-awareness, emotional intelligence [27], and effective communication, mindfulness promotes a deeper understanding of diverse perspectives and cultivates clarity and conciseness in expressing complex engineering ideas. It enhances empathy, emotional regulation, and conflict resolution skills [28], leading to more effective collaboration within engineering teams.

Therefore, incorporating mindfulness practices into engineering education becomes imperative to address prevailing issues. The lack of discussion around emotions and the tendency to deal with

challenges in isolation, driven by "professional shame" [29], lead to mental health concerns and strained relationships among faculty and students. Mindfulness addresses this by breaking the silence, fostering open communication, and creating a supportive environment. Mindfulness practices promote students sharing more and faculty listening more through mindful listening, ultimately improving communication skills and teamwork [20]. Practicing mindfulness collectively enables faculty and students to build better relationships and maintain positive social connections, contributing to a healthier educational environment.

To Enhance Academic Outcomes

At its core, mindfulness is a practice that involves enhancing awareness of the present moment, which can significantly improve skills necessary for successful academic outcomes such as sustained focus, increased open-mindedness and innovation, and time management. Sustained focus is crucial for engineering students who must master complex concepts and problem-solving skills. Mindfulness practices help train the mind to resist distractions and redirect attention to the task [30]. By regularly engaging in mindfulness practices, engineering students can develop the mental discipline to stay focused during lectures, laboratory work, and study sessions. In addition to improving concentration, mindfulness promotes a non-judgmental and open-minded approach to thoughts and ideas. This mindset benefits engineering students who need to be creative and innovative problem solvers. Practicing mindfulness allows students to observe their thoughts without immediately categorizing them as right or wrong. This non-judgmental approach encourages a more creative and exploratory mindset, allowing students to consider alternative perspectives and solutions to engineering challenges [31].

Furthermore, mindfulness can improve time management skills by promoting greater awareness of how time is utilized. Through mindfulness practices, students can gain better insight into their priorities and allocate their time more efficiently among different tasks. This leads to a more organized and efficient approach to academic responsibilities, reducing the likelihood of feeling overwhelmed and enhancing overall productivity in engineering coursework.

At the same time, research studies have uncovered physical and neurological benefits of mindfulness on the brain, showing that practicing mindfulness can increase the density of brain regions responsible for learning and memory [32] and improve the ability to focus attention selectively [33]. Moreover, undergraduate students who practice mindfulness exhibit lower levels of state anxiety in high-pressure testing situations, which can facilitate improved accuracy and learning efficiency [34].

Research Question 2: What are the potential challenges for Implementing Mindfulness?

While we have explored the need and benefits of mindfulness in engineering education, we address our second research question by examining literature related to the challenges and other practical implications for integrating mindfulness as a pedagogical practice, specifically within engineering classrooms.

Skepticism surrounding the Use and Value of Mindfulness in Engineering

Integrating mindfulness into engineering education offers potential benefits but faces several key challenges. One significant challenge is addressing the skepticism about the relevance of mindfulness in a field traditionally focused on technical aspects [35] [36]. Successfully implementing mindfulness in engineering education involves creating an environment that respects and acknowledges these differences, encouraging open-mindedness and adaptability. To address this, it is essential to present mindfulness as a scientific strategy. This involves using empirical research, statistical data, real-world examples, and case studies to illustrate its evidence-based benefits. By demonstrating how mindfulness can serve as a valuable tool for professional development, engineering students can begin to appreciate its practical application in enhancing their careers.

Making Time for Mindfulness

We must balance mindfulness activities and core engineering material while respecting diverse backgrounds and beliefs. Integrating additional content, such as mindfulness, into an already packed engineering curriculum can be challenging, as it requires not only finding space but also ensuring the relevance and value of every component. Moreover, these additions must be designed to seamlessly blend with traditional subjects without overwhelming students or detracting from their primary educational objectives. Incorporating mindfulness into the busy schedules of engineering students also presents a significant challenge. Often, students prioritize activities that directly impact their grades, leading to hesitation in participating in activities [37], like mindfulness practices that are optional and not integrated into the core curriculum. This tendency can widen the gap in mental health support, especially for non-traditional students who juggle work and study. Addressing this issue is crucial for creating an inclusive educational environment. Integrating mindfulness more closely with academic activities and making it accessible for all students, regardless of their schedules, could ensure equitable mental health support. Embedding such practices into the curriculum could foster broader participation and benefits.

Conclusion

Mindfulness is essential to a student's well-being, and incorporating it into the engineering curriculum can be a transformative practice. To do this, it can be woven into existing academic structures without overburdening students' and faculty schedules. By incorporating practices like mindful observation into problem-solving steps, students are encouraged to concentrate intently on the task at hand. Faculty members have a crucial role in supporting students' well-being [38], and they can directly address their learning- and course-based needs better than counselors or therapists. By training faculty members in mindfulness, they can immediately support students and make mindfulness part of the curriculum and everyday classroom interactions. This approach fosters well-being and strengthens the faculty-student connection. Initially, mindfulness may seem unrelated to engineering, but its introduction is essential. Workshops and expert speakers with engineering backgrounds can demonstrate its relevance, encouraging students to adopt it. Establishing mindfulness clubs can also offer a community-based support system, fostering a sense of belonging and accommodating different schedules. However, integrating mindfulness into the curriculum requires further research and a commitment from

both faculty and students. By embracing this transformative practice, students can improve their well-being and performance, creating a more positive and successful academic environment.

Promoting an environment where everyone feels comfortable seeking help is crucial. Managing stress is key to overcoming mental health issues [39] and creating a positive ripple effect that extends to those around us. By focusing on stress management, we can empower individuals to proactively navigate challenges - rather than reactively - and contribute to a supportive community.

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References

[1] P. Moen, “The Uneven Stress of Social Change: Disruptions, Disparities, and Mental Health,” *Soc. Ment. Health*, vol. 12, no. 2, pp. 85–98, Jul. 2022, doi: 10.1177/21568693221100171.

[2] Z. Abrams, “Student mental health is in crisis. Campuses are rethinking their approach,” *Monit. Psychol.*, vol. 53, no. 7, p. 60, 2022, doi: https://www.apa.org/monitor/2022/10/mental-health-campus-care.

[3] T. N. Hanh, *Peace Is Every Step*. Bantam Books, 1992.

[4] J. Kabat-Zinn, *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness, 15th anniversary ed*. in Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness, 15th anniversary ed. New York, NY, US: Delta Trade Paperback/Bantam Dell, 2005, pp. xxxiii, 471.

[5] R. Stevens, D. Amos, A. Jocuns, and L. Garrison, “Engineering As Lifestyle And A Meritocracy Of Difficulty: Two Pervasive Beliefs Among Engineering Students And Their Possible Effects,” in *2007 Annual Conference & Exposition Proceedings*, Honolulu, Hawaii: ASEE Conferences, Jun. 2007, p. 12.618.1-12.618.17. doi: 10.18260/1-2--2791.

[6] H. Dryburgh, “WORK HARD, PLAY HARD: Women and Professionalization in Engineering—Adapting to the Culture,” *Gend. Soc.*, vol. 13, no. 5, pp. 664–682, Oct. 1999, doi: 10.1177/089124399013005006.

[7] C. McCall, A. Shew, D. R. Simmons, M. C. Paretti, and L. D. McNair, “Exploring student disability and professional identity: navigating sociocultural expectations in U.S. undergraduate civil engineering programs,” *Australas. J. Eng. Educ.*, vol. 25, no. 1, pp. 79–89, Jan. 2020, doi: 10.1080/22054952.2020.1720434.

[8] L. Davenport Huyer *et al.*, “Enhancing senior high school student engagement and academic performance using an inclusive and scalable inquiry-based program,” *Npj Sci. Learn.*, vol. 5, no. 1, Art. no. 1, Dec. 2020, doi: 10.1038/s41539-020-00076-2.

[9] S. K. Lipson, S. Zhou, B. Wagner III, K. Beck, and D. Eisenberg, “Major Differences: Variations in Undergraduate and Graduate Student Mental Health and Treatment

Utilization Across Academic Disciplines," *J. Coll. Stud. Psychother.*, vol. 30, no. 1, pp. 23–41, Jan. 2016, doi: 10.1080/87568225.2016.1105657.
[10] S. Secules, Maimuna B. Kali, C. J. McCall, and G. V. Dyke, "Minoritized Student Audio Narratives to Influence Faculty's Empathic Understanding: Learning from Sophie and Enola," presented at the Collaborative Network for Engineering & Computing Diversity (CoNECD), Arlington, Virginia, 2024. doi: 10.18260/1-2--45461.
[11] T. G. Osborn, S. Li, R. Saunders, and P. Fonagy, "University students' use of mental health services: a systematic review and meta-analysis," *Int. J. Ment. Health Syst.*, vol. 16, no. 1, p. 57, Dec. 2022, doi: 10.1186/s13033-022-00569-0.
[12] J. Hyun, B. Quinn, T. Madon, and S. Lustig, "Mental Health Need, Awareness, and Use of Counseling Services Among International Graduate Students," *J. Am. Coll. Health*, vol. 56, no. 2, pp. 109–118, Oct. 2007.
[13] J. K. Hyun, B. C. Quinn, T. Madon, and S. Lustig, "Graduate Student Mental Health: Needs Assessment and Utilization of Counseling Services," *J. Coll. Stud. Dev.*, vol. 47, no. 3, pp. 247–266, 2006.
[14] D. A. Danowitz, C. P. S. University, S. L. Obispo, and D. K. Beddoes, "Characterizing Mental Health and Wellness in Students Across Engineering Disciplines".
[15] G. Russell and S. Lightman, "The human stress response," *Nat. Rev. Endocrinol.*, vol. 15, no. 9, Art. no. 9, Sep. 2019, doi: 10.1038/s41574-019-0228-0.
[16] K. J. Jensen and K. J. Cross, "Engineering stress culture: Relationships among mental health, engineering identity, and sense of inclusion," *J. Eng. Educ.*, vol. 110, no. 2, pp. 371–392, 2021, doi: 10.1002/jee.20391.
[17] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, "Leaving Engineering: A Multi-Year Single Institution Study," *Journey Eng. Educ.*, vol. 101, no. 1, pp. 6–27, Jan. 2013, doi: https://doi.org/10.1002/j.2168-9830.2012.tb00039.x.
[18] X. Chen, "STEM Attrition: College Students' Paths Into and Out of STEM Fields," 2013.
[19] A. Aguirre Velasco, I. S. S. Cruz, J. Billings, M. Jimenez, and S. Rowe, "What are the barriers, facilitators and interventions targeting help-seeking behaviours for common mental health problems in adolescents? A systematic review," *BMC Psychiatry*, vol. 20, no. 1, p. 293, Jun. 2020, doi: 10.1186/s12888-020-02659-0.
[20] Z. Schuman-Olivier *et al.*, "Mindfulness and Behavior Change," *Harv. Rev. Psychiatry*, vol. 28, no. 6, pp. 371–394, 2020, doi: 10.1097/HRP.0000000000000277.
[21] N. A. S. Farb, A. K. Anderson, H. Mayberg, J. Bean, D. McKeon, and Z. V. Segal, "Minding One's Emotions: Mindfulness Training Alters the Neural Expression of Sadness," *Emot. Wash. DC*, vol. 10, no. 1, pp. 25–33, Feb. 2010, doi: 10.1037/a0017151.
[22] M. A. Burzler, M. Voracek, M. Hos, and U. S. Tran, "Mechanisms of Mindfulness in the General Population," *Mindfulness*, vol. 10, no. 3, pp. 469–480, Mar. 2019, doi: 10.1007/s12671-018-0988-y.
[23] M. Komariah, K. Ibrahim, T. Pahria, L. Rahayuwati, and I. Somantri, "Effect of Mindfulness Breathing Meditation on Depression, Anxiety, and Stress: A Randomized Controlled Trial among University Students," *Healthcare*, vol. 11, no. 1, Art. no. 1, Jan. 2023, doi: 10.3390/healthcare11010026.

[24] G. W. Fincham, C. Strauss, J. Montero-Marin, and K. Cavanagh, “Effect of breathwork on stress and mental health: A meta-analysis of randomised-controlled trials,” *Sci. Rep.*, vol. 13, no. 1, Art. no. 1, Jan. 2023, doi: 10.1038/s41598-022-27247-y.
[25] A. Powell, “Harvard researchers study how mindfulness may change the brain in depressed patients,” Harvard Gazette. Accessed: Feb. 07, 2024. [Online]. Available: https://news.harvard.edu/gazette/story/2018/04/harvard-researchers-study-how-mindfulness-may-change-the-brain-in-depressed-patients/
[26] A. Diaz Lantada, A. Hernández Bayo, and J. de J. Marquez Sevillano, “Promotion of professional skills in engineering education: strategies and challenges,” *Int. J. Eng. Educ.*, vol. 30, no. 6(B), Art. no. 6(B), 2014.
[27] S. Guendelman, S. Medeiros, and H. Rampes, “Mindfulness and Emotion Regulation: Insights from Neurobiological, Psychological, and Clinical Studies,” *Front. Psychol.*, vol. 8, Mar. 2017, doi: 10.3389/fpsyg.2017.00220.
[28] K. Beddoes and A. Danowitz, “In Their Own Words: How Aspects of Engineering Education Undermine Students’ Mental Health,” presented at the 2022 ASEE Annual Conference & Exposition, Aug. 2022. Accessed: Oct. 08, 2023. [Online]. Available: https://peer.asee.org/in-their-own-words-how-aspects-of-engineering-education-undermine-students-mental-health
[29] S. Secules, N. W. Sochacka, J. L. Huff, and J. Walther, “The Social Construction of Professional Shame for Undergraduate Engineering Students,” *J. Eng. Educ.*, vol. 110, no. 4, pp. 861–884, Oct. 2021, doi: 10.1002/jee.20419.
[30] D. Hussain, “Meta-Cognition in Mindfulness: A Conceptual Analysis,” *Psychol. Thought*, vol. 8, no. 2, pp. 132–141, Jul. 2015, doi: 10.5964/psyct.v8i2.139.
[31] B. Rieken, M. Schar, S. Shapiro, S. Gilmartin, and S. Sheppard, “Exploring the Relationship between Mindfulness and Innovation in Engineering Students.,” *Proc. Am. Soc. Eng. Educ. Annu. Conf. June 25-28 Columb. OH*, Jan. 2017, Accessed: Oct. 04, 2023. [Online]. Available: https://par.nsf.gov/biblio/10043005-exploring-relationship-between-mindfulness-innovation-engineering-students
[32] B. K. Hölzel *et al.*, “Mindfulness practice leads to increases in regional brain gray matter density,” *Psychiatry Res.*, vol. 191, no. 1, pp. 36–43, Jan. 2011, doi: 10.1016/j.pscychresns.2010.08.006.
[33] M. Napoli, P. R. Krech, and L. C. Holley, “Mindfulness Training for Elementary School Students: The Attention Academy,” *J. Appl. Sch. Psychol.*, vol. 21, no. 1, pp. 99–125, 2005, doi: 10.1300/J370v21n01_05.
[34] S.-L. Keng, M. J. Smoski, and C. J. Robins, “Effects of Mindfulness on Psychological Health: A Review of Empirical Studies,” *Clin. Psychol. Rev.*, vol. 31, no. 6, pp. 1041–1056, Aug. 2011, doi: 10.1016/j.cpr.2011.04.006.
[35] E. Dixon, “Mindful Engineering Part 4: Why engineers need mindfulness.” Accessed: Feb. 04, 2024. [Online]. Available: https://www.asce.org/publications-and-news/civil-engineering-source/article/2021/12/27/why-engineers-need-mindfulness
[36] B. C. Lines, K. T. Sullivan, J. B. Smithwick, and J. Mischung, “Overcoming resistance to change in engineering and construction: Change management factors for owner organizations,” *Int. J. Proj. Manag.*, vol. 33, no. 5, pp. 1170–1179, Jul. 2015, doi: 10.1016/j.ijproman.2015.01.008.

[37] A. Olewnik, Y. Chang, and M. Su, “Co-curricular engagement among engineering undergrads: do they have the time and motivation?,” *Int. J. STEM Educ.*, vol. 10, no. 1, p. 27, Apr. 2023, doi: 10.1186/s40594-023-00410-1.
[38] V. LaMastro, “Influence of perceived institutional and faculty support on college students’ attitudes and behavioral intentions,” *Psychol. Rep.*, vol. 88, no. 2, pp. 567–580, Apr. 2001, doi: 10.2466/pr0.2001.88.2.567.
[39] D. Saleh, N. Camart, F. Sbeira, and L. Romo, “Can we learn to manage stress? A randomized controlled trial carried out on university students,” *PloS One*, vol. 13, no. 9, p. e0200997, 2018, doi: 10.1371/journal.pone.0200997.