

## **WIP: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness**

### **Isabel Miller, University of Illinois at Urbana - Champaign**

Isabel Miller (she/her) is pursuing a MS in Bioengineering at the University of Illinois Urbana-Champaign, having received her Bachelors in Bioengineering in 2021 from UIUC. She is interested in student mental health and wellness.

### **Sara Xochilt Lamer, University of Illinois at Urbana - Champaign**

Sara Lamer (she/her) is a junior studying Mechanical Engineering at the University of Illinois at Urbana-Champaign. She is an ARISE scholar in the Grainger College of Engineering. Sara performs undergraduate research in soft robotics and engineering education funded by the IDEA Institute at UIUC. Sara is interested in pursuing a career in Engineering Education as well as furthering her education upon graduating.

### **Dr. Karin Jensen, University of Illinois at Urbana - Champaign**

Karin Jensen, Ph.D. is a Teaching Assistant Professor in bioengineering at the University of Illinois Urbana-Champaign. Her research interests include student mental health and wellness, engineering student career pathways, and engagement of engineering faculty in engineering education research. She was awarded a CAREER award from the National Science Foundation for her research on undergraduate mental health in engineering programs. Before joining UIUC she completed a post-doctoral fellowship at Sanofi Oncology in Cambridge, MA. She earned a bachelor's degree in biological engineering from Cornell University and a Ph.D. in biomedical engineering from the University of Virginia.

### **Prof. Holly M. Golecki, University of Illinois at Urbana - Champaign**

Dr. Holly Golecki (she/her) is a Teaching Assistant Professor in Bioengineering at the University of Illinois Urbana-Champaign and an Associate in the John A Paulson School of Engineering and Applied Sciences at Harvard University. She holds an appointment at the Carle-Illinois College of Medicine in the Department of Biomedical and Translational Sciences. She is also a core faculty member at the Institute for Inclusion, Diversity, Equity, and Access in the College of Engineering. Holly studies biomaterials and soft robotics and their applications in the university classroom, in undergraduate research and in engaging K12 students in STEM. Holly received her BS in Materials Science and Engineering from Drexel University and her PhD in Engineering Sciences from Harvard University.

# **Work in Progress: Supporting Student Mental Health: Understanding the Use of Biometrics Analysis in an Engineering Design Project to Promote Wellness**

## **Introduction**

The current COVID-19 pandemic is exacerbating existing mental health issues across college campuses. Students have reported higher levels of stress and anxiety [1, 2] and alcohol misuse [3] due to the pandemic. Mindfulness is one tool able to reduce levels of mood disorders, and improve a person's ability to cope with stress [4, 5]. Previous studies implementing mindfulness activities into curricula have shown improvements to student mental health, specifically the reduction of perceived stress [6, 7] and anxiety [8]. Through curricular developments, we aim to explore the impact of introducing students to mindfulness and other wellness practices in a design project, empowering students to engage in wellness practices outside of class. To do so, we redesigned a project in an introductory bioengineering course to explore stress management techniques through physiology, biosensors, and design. The project allows students to develop design skills and to explore the impact of wellness practices on human physiology. Assessment of the curricular redesign will be measured by student evaluations of the offering and their willingness to engage in the mindfulness portion of the course. The COVID-19 pandemic has emphasized the need to focus on student wellbeing in addition to physical health. Integration of wellness into the core curriculum promotes the use of existing campus resources presented in class and may normalize the use of these resources within engineering departments and colleges. Ultimately, the project will lay the groundwork for institutional enhancement of undergraduate STEM education by supporting student wellness through data-driven design.

## **Methods**

*Course Structure* In the introductory bioengineering course, finger pulse oximeters are distributed to 100 first-year bioengineering students each year to complete a hands-on project in which they develop a hypothesis around activities that impact pulse rate and oxygen saturation (SpO<sub>2</sub>). Students are directed to test their hypothesis by measuring heart rate and SpO<sub>2</sub> before and after performing an activity of their choosing. They test their hypothesis using pulse oximeter devices during the semester. Typical examples of hypothesis included running upstairs, singing loudly, and drinking water. In the 2019 offering course instructors noticed a trend, that year ~28% of students independently developed hypotheses measuring stressful events or wellness practices, demonstrating student awareness of the impacts of stress on the body and an opportunity to engage students in this area. We took this opportunity to redesign the existing project to focus on physiological impacts of stress management techniques and leverage data analysis to reveal physical benefits to engineering students. In the 2020 offering, students were taught about physiologic impacts of stress and all students were asked to formulate their hypothesis around a practice that can be used for stress relief. Students were introduced to mindfulness. Other examples presented to students for inspiration included meditation, yoga, listening to calming music, or exercise. We believe that if students measure objective, physiologic impacts of stress management on themselves, they may be more likely to realize the benefits and use those techniques when needed. Additionally, this project uses an objective, data-driven approach to appeal to engineering students.

In the revised project used in this analysis of the Fall 2020 course offering, students explore other devices used to measure additional physiological markers of stress, including heart rate

variation and skin conductance, while simultaneously learning stress management techniques, including mindfulness techniques. Participating in mindfulness activities during or outside of class was optional. In groups, students design experiments to measure the physiological impact of their chosen stress management technique. Students self-organized into testing different hypothesis approximately evenly among mindfulness meditation, yoga, listening to music and exercise. Later, students analyzed their own biometric data and visualized significant trends. After data collection and analysis, students analyzed device functionality and design through usability heuristics and proposed improved device design through use of design heuristics.

*Survey* Institutional Review Board approval was obtained to administer two surveys to students enrolled in the course (University of Illinois Urbana Champaign IRB #21171). Two optional surveys were developed and sent to students in Week 4 of the semester after being introduced to the project and before Week 13 of the semester at the end of the semester. The surveys were anonymous and administered via SurveyMonkey. Students were offered entry into a raffle for one of five \$50 Amazon gift cards for each survey completed. The pre- and post-surveys had 37.9% and 17.2% response rates, respectively. Both the pre- and post- surveys asked students about mindfulness and their practice (See Appendix). Additional questions regarding quality of the project were included in the post-survey (See Appendix). Because mindfulness was used in class lectures as an examples and mindfulness sessions were run during class, we expect that all students can answer the mindfulness-based questions regardless of their project hypothesis. In this pilot survey, we did not ask students to identify their chosen hypothesis. In future offering we will include this question in the post-project survey.

## Results

Pre-survey results show that students were aware of what mindfulness was before this course and were aware of potential benefits to practicing mindfulness. Themes from the pre-survey distributed to students and example comments on describing mindfulness are shown in Table 1. Most of the responses referenced mindfulness as being present or aware of oneself.

**Table 1. Themes from student feedback on describing mindfulness pre-survey.**

Theme	Number of Responses	Example student comments
Awareness of self	15	“conscious awareness of their state of being.”
Being in the present	11	“Being aware of your surroundings.”
Breathing practices	1	“Focusing on your breathing to relieve stress”
Mental health	6	“Mindfulness is a practice of taking care of one's mental health”
De-stress/relaxation	5	“An activity in which you focus on you and de-stress.”

Themes from the pre-survey and example comments on the benefits of mindfulness are show in Table 2. Students identified both physical and mental benefits to practicing mindfulness. The most common theme for a potential benefit for mindfulness was relaxation.

Twenty students participated in mindfulness activities for their project, while other groups chose different activities. Students were asked to self-report their frequency of participation in mindfulness activities. Out of 15 responses to the survey, all students reported participating in a mindfulness activity at some point. Zero respondents reported never participating, nine respondents reported participating occasionally, three respondents each reported participating weekly and almost every day, and zero respondents reported participating every day. Responses

indicate students participated at least once suggesting students are open to trying wellness activities in class. Common reasons from students on why they choose not to participate in activities all the time were being “too busy” or “not having enough time.” Incorporating wellness activities directly into courses could help solve these barriers by providing a scheduled time and place to practice wellness.

**Table 2. Themes from student’s pre-survey responses about benefits to mindfulness.**

Theme	Number of responses	Example student comments
Calming/relaxing	11	“It helps to destress”
Improves focus	7	“organizing my thoughts”
Improves physical health	5	“lower blood pressure”
Introspection/awareness	5	“Identifying behavioral patterns that impact mental health”
Less anxiety	5	“It helps lower anxiety”
Emotional regulation	3	“Allows one to control emotions and to think big picture”
Improves sleep	2	“Better sleep”

### Discussion and Future Work

Student’s awareness of mindfulness and its benefits before a formal introduction suggests that students are actively seeking out information about wellness independently. Wellness and specifically mindfulness have become popular outside of the medical field. Big tech companies like Google and Apple have publicly promoted mindfulness practices and helped make it more mainstream [9]. This is consistent with previous work offering mindfulness to engineering students having shown that they are interested and receptive to practicing [10-12]. This opens a possibility for instructors to introduce stress-management concepts in other engineering courses, as an introduction to engineering design, in an introductory electrical engineering class that builds similar devices, and any course that discusses user centered design. The project can be used to promote wellness to their students and normalize use of wellness resources on campus, such as Mindfulness programs, counseling, and workshops offered by a counseling center. Normalizing talking about mental health and wellness and making students aware of resources and benefits can help lower stigma, a significant predictor of lower help-seeking [13-14]. One limitation of the current study is only one course at one institution was studied. Our results may not be representative of a general student population and may not be repeatable. We were also limited in our ability to assess the change in student’s perceptions and practices concerning mindfulness because we were unable to link pre- and post- surveys. Low survey response may have been influenced by the influx of surveys students have been receiving from across the university in response to COVID-19. The low response rate has been similar in other studies at the college this year. In future surveys, we may change the incentive by offering a monetary reward for completing the survey or give students time in class to complete the survey on a day when the instructor leaves class early to avoid feelings of coercion. In future offerings of this course, students will be provided with more devices to analyze different types of biometric data, such as skin-conductance. In future studies we will investigate the specific impact of the activities in promoting wellness, as well the use of wellness techniques and campus resources longitudinally after participating in the course.

### Acknowledgments

This project was supported by the University of Illinois Faculty Retreat Grant and the Department of Bioengineering. The authors thank the students for sharing their perspectives.

## References

- [1] X. Wang, S. Hegde, C. Son, B. Keller, A. Smith, and F. Sasangohar, "Investigating Mental Health of US College Students During the COVID-19 Pandemic: Cross-Sectional Survey Study," *J. Med. Internet Res.*, vol. 22, no. 9, p. e22817, Sep. 2020, doi: 10.2196/22817.
- [2] A. Kecojevic, C. H. Basch, M. Sullivan, and N. K. Davi, "The impact of the COVID-19 epidemic on mental health of undergraduate students in New Jersey, cross-sectional study," *PLOS ONE*, vol. 15, no. 9, p. e0239696, Sep. 2020, doi: 10.1371/journal.pone.0239696.
- [3] N. E. Charles, S. J. Strong, L. C. Burns, M. R. Bullerjahn, and K. M. Serafine, "Increased mood disorder symptoms, perceived stress, and alcohol use among college students during the COVID-19 pandemic," *Psychiatry Res.*, vol. 296, p. 113706, Feb. 2021, doi: 10.1016/j.psychres.2021.113706.
- [4] J. N. Donald and P. W. B. Atkins, "Mindfulness and Coping with Stress: Do Levels of Perceived Stress Matter?," *Mindfulness*, vol. 7, no. 6, pp. 1423–1436, Dec. 2016, doi: 10.1007/s12671-016-0584-y.
- [5] A. Masuda and E. C. Tully, "The Role of Mindfulness and Psychological Flexibility in Somatization, Depression, Anxiety, and General Psychological Distress in a Nonclinical College Sample," *J. Evid.-Based Complement. Altern. Med.*, vol. 17, no. 1, pp. 66–71, Jan. 2012, doi: 10.1177/2156587211423400.
- [6] K. Caldwell, M. Harrison, M. Adams, R. H. Quin, and J. Greeson, "Developing Mindfulness in College Students Through Movement-Based Courses: Effects on Self-Regulatory Self-Efficacy, Mood, Stress, and Sleep Quality," *J. Am. Coll. Health*, vol. 58, no. 5, pp. 433–442, Mar. 2010, doi: 10.1080/07448480903540481.
- [7] T. R. Ramler, L. R. Tennison, J. Lynch, and P. Murphy, "Mindfulness and the College Transition: The Efficacy of an Adapted Mindfulness-Based Stress Reduction Intervention in Fostering Adjustment among First-Year Students," *Mindfulness*, vol. 7, no. 1, pp. 179–188, Feb. 2016, doi: 10.1007/s12671-015-0398-3.
- [8] D. B. Bellinger, M. S. DeCaro, and P. A. S. Ralston, "Mindfulness, anxiety, and high-stakes mathematics performance in the laboratory and classroom," *Conscious. Cogn.*, vol. 37, pp. 123–132, Dec. 2015, doi: 10.1016/j.concog.2015.09.001.
- [9] A. P. King, "Mindfulness-Based Workplace Interventions for Wellness Promotion," in *Mental Health in the Workplace*, M. B. Riba, S. V. Parikh, and J. F. Greden, Eds. Cham: Springer International Publishing, 2019, pp. 191–208. doi: 10.1007/978-3-030-04266-0\_13.
- [10] J. S. Ge, E. J. Berger, J. C. Major, and J. M. Froiland, "Teaching Undergraduate Engineering Students Gratitude, Meaning, and Mindfulness," in *ASEE Annual Conference and Exposition*, Tampa, Florida, 2019.
- [11] M. M. V. Huerta, "Inner Engineering: A Convergent Mixed Methods Study Evaluating the Use of Contemplative Practices to Promote Resilience Among Freshman Engineering Students," in *ASEE Annual Conference and Exposition*, 2018.
- [12] I. Miller and K. Jensen, "Introduction of Mindfulness in an Online Engineering Core Course During the COVID-19 Pandemic," *Advances in Engineering Education*, 2020.
- [13] D. Eisenberg and K. Zivin, "Stigma and help seeking for mental health among college students," *Medical care research and review*, vol. 66, pp. 522-541, 2009.
- [14] R.A. Vidourek, K.A. King, L.A. Nabors, and A.L. Merianos, "Students' benefits and barriers to mental health help-seeking," *Health psychology and behavioral medicine*, vol. 2(1), pp. 1009-1022, 2014.

## Appendix

### Pre-Survey Questions

1. How would you describe mindfulness?
2. How often do you practice mindfulness techniques?  
Not Familiar   Never   Occasionally   Almost Every Day   Weekly   Every Day
3. What benefits, if any, do you see for practicing mindfulness?
4. How likely are you to incorporate mindfulness activities into your daily life?  
Highly unlikely   Somewhat unlikely   Somewhat likely   Highly likely
5. Have you ever used a device (such as a heart rate monitor, FitBit or Apple Watch) to measure and track biometric data?  
Yes   No
6. Is there anything else you would like to share that was not included on the survey?

### Post-Survey Questions

1. How frequently did you participate in mindfulness activities this semester?  
Never   Occasionally   Almost Every Day   Weekly   Every Day
2. If you chose not to participate in the mindfulness practice, or did not participate often, please explain what factors influenced your decision.
3. What benefits, if any, do you see for practicing mindfulness?
4. How likely are you to incorporate mindfulness activities into your daily life beyond this class?  
Highly unlikely   Somewhat unlikely   Somewhat likely   Highly likely
5. Did the use of pulse oximeters help you monitor or become more aware of stress in your life?  
Yes   No   I didn't use the measurement this way
6. Did using pulse oximeters in Project 1 give you a better sense of design features to include for improved stress tracking devices?
7. After completing Project 1, would you be more likely to incorporate wellness practices into your life?  
Yes   No   Somewhat
8. What did you like about the wellness portion of BIOE100 and Project 1?
9. Please provide suggestions for improvements in the wellness portion of BIOE100.
10. Is there anything else you would like to share that was not included on the survey?