Relationships between Biometric Indicators and Psychological Experiences of Thriving

Noah Pointer, Biologically Inspired Design for Resilience(BID4R) lab.

Noah Pointer is a first generation college student and veteran of the United States Army. He is currently pursuing his Bachelor's of Science in Software Engineering and is a recipient of the SAGE-STEM scholarship. He plans on pursuing an accelerated Master's of Science in Software Engineering and continuing research throughout his academic career.

Julianna Gesun, Embry-Riddle Aeronautical University - Daytona Beach

Julianna Gesun, Ph.D., is currently a postdoc researcher at Embry-Riddle. Her research broadly focuses on understanding and supporting the process by which engineering programs facilitate the environments for students to develop optimal functioning in undergraduate engineering programs. Her research interests intersect the fields of positive psychology, engineering education, and human development to understand the intrapersonal, cognitive, social, behavioral, contextual, cultural, and outcome factors that influence thriving in engineering.

Prior to joining Embry-Riddle, she was a National Science Foundation/American Society for Engineering Education engineering postdoctoral fellow at the University of New Hampshire. She received her Ph.D. in Engineering Education at Purdue University, where she was an NSF Graduate Research Fellow and the winner of Purdue's 2021 Three Minute Thesis competition for her work in developing research and courses on engineering thriving. She also received dual bachelor's degrees in Industrial Engineering and Human Development and Family Studies at the University of Illinois at Urbana-Champaign. Her prior work experiences include product management, consulting, tutoring, marketing, and information technology.

Bryan Watson, Embry-Riddle Aeronautical University - Daytona Beach

Bryan Watson, PE earned his Ph.D. at the Georgia Institute of Technology and his B.S. in Systems Engineering at the United States Naval Academy in 2009. After graduating, Bryan joined the nuclear Navy, serving as a submarine officer onboard the U.S.S Louisville and at the Naval Prototype Training Unit from 2009-2017. Significant milestones include earning the Master Training Specialist Certification (the military's highest instructor accreditation), Nuclear Professional Engineer Certification, two Naval Achievement Medals, the Military Outstanding Volunteer Service Medal, and a Naval Commendation Medal for his work troubleshooting and repairing the Moored Training Ship 635's reactor and electrical distribution faults. Following his transition from active duty, Bryan earned his PhD as a member of both the Computation and Advancement of Sustainable Systems Lab, where he developed a new method for distributed system demand estimation, and at the Sustainable Design and Manufacturing lab, where his work focused on increasing System of System resilience. Bryan's work has been published in the Journal of Industrial Ecology, Journal of Mechanical Design, and IEEE's Systems Journal.

At Embry-Riddle, Bryan's current work is focused on investigating the use of biologically inspired design to increase the resilience of modern system. The goal of their work is more reliable services to users, increased user safety, and increased sustainability for connected manufacturing, energy, and infrastructure systems.

Work In Progress: Identifying Relationships between Biometric Indicators and Psychological Experiences of Thriving in Veteran Students

Abstract

Many efforts have been implemented to support veteran success, including the Supporting Veterans in STEM Act and the NSF Veterans Research Supplement Program. However, only about 14% of veterans choose to study in a STEM discipline. A key challenge is identifying veteran students who are not thriving in their program, especially as this population has been identified as a group that is less connected to the student body and is less likely to seek help from faculty. This Work-in-Progress presents an overview of relationships between psychological and physiological experiences of thriving and serves as foundational research that will guide a study investigating those relationships in an undergraduate veteran student engineering community. This study builds on prior work on engineering thriving, which is broadly defined as the process by which engineering programs facilitate the environments for students to develop optimal functioning in engineering programs. The research question in the proposed study is to identify the key indicators of thriving in undergraduate veteran engineering students. Prior research has provided established relationships between some of the biometric indicators being measured and some of the categories of the thriving survey which will assist in guiding the study design and in the selection of which biometrics will be measured. The purpose of sharing this paper now is to facilitate feedback from members conducting research involving veterans and to network with potential future collaborators. The focus of this paper discusses the reasonings for which biometric variables and which thriving categories we are most interested in based on the literature and studies using similar metrics.

Introduction

Intuition suggests that an increase in sleep would boost subjective well-being in undergraduate engineering students and that an increase in exercise would ultimately improve their self-perception. These are concepts we intuitively understand; however, few studies have explored how biometric indicators relate to subjective well-being, or more specifically, Engineering Thriving. Engineering Thriving is defined as the process by which engineering programs facilitate the environments for students to develop optimal functioning in engineering programs [1]. The significance of this study lies in the need to identify physical indicators or biomarkers that correlate with a student's subjective psychological experience, and, if such indicators exist, to answer our research question regarding the key indicators of thriving. Although survey tools have been developed to assess thriving in undergraduate engineering students [2], physical indicators are necessary for students who may be less likely to engage with survey tools. For this work-in-progress, we choose to focus on Veteran students, who are less connected to the student body and less likely to seek faculty assistance [3].

Thus, the key research question in the proposed study is: *What are the key indicators of thriving in undergraduate veteran engineering students?* The hypothesis we plan to investigate is: *If we measure physiological and physiological markers of thriving for a veteran student population, then we will be able to determine relationships between these markers to provide insight for educational interventions.* Our long-term goal is that these insights will provide insights for all educators and be leveraged to increase student retention and thriving.

This work-in-progress paper performs three key functions:

1. We seek feedback on our rationale for the biometric markers we plan to evaluate and our reasoning for selection.

2. We seek feedback from experts in the ASEE Military and Veterans Division with experience in conducting research with veteran students for insights into working with this population.

3. We seek to identify interested individuals who may be interested in future multi-campus collaboration and study, leveraging the results of this study.

The remainder of this Work-In-Progress paper is as follows. First, the background literature on physiological markers of thriving is presented with biometric selection. Next, the expected relationships between dimensions of thriving and biometric markers are discussed. The paper closes with a discussion of the study's limitations and future steps.

Biometric Selection

Prior research has established a strong foundation concerning the relationship between biometric physical indicators and psychological experiences. From ancient civilizations to the modern "Mind-Body Problem," understanding the complex relationship between body and mind has been a focus of human inquiry since the dawn of recorded history [4], [5]. Despite decades of research, there is still much to explore, and novel approaches are necessary to further investigate these connections. This section will discuss the extent to which these connections are understood, whether any biometric indicators can predict thriving, and the expected outcomes of this study.

Of note, biometric indicators in this study do not fall under the usual definition of biometrics, such as fingerprints, facial structures, and other personal identifiers used for security purposes [6]. Instead, the biometrics in this study are related more similarly to health metrics and physiological measurements of biological behaviors. While these are also described as biometrics, they are not as commonly recognized as personal identifiers [7]. Examples of these biometrics as the ones used in the study include average resting heart rate, heart rate variability, maximum heart rate, sleep duration, step count, pulse oximetry (oxygen levels in blood), and exercise duration, among others.

We choose to focus on three biometrics, based on prior research, data availability, and ease of user input. The tool we plan to use for our study is a Garmin smartwatch with the Garmin Connect application. This tool was selected due to its cost, wide range of biometrics, and use in the published literature [8], [9]. Garmin Connect provides various downloadable reports, but some require consistent user input, such as daily hydration and calorie intake, which are excluded from this study. Consequently, only the biometrics that are automatically captured through Garmin's algorithms and sensors will be considered. After review, the biometrics that were reviewed for this study are the following: Resting heart rate, Intensity Minutes (Aerobic exercise), daily step count, sleep duration, and Garmin's stress level [10].

Prior studies have shown that heart rate is positively related to both psychological and physical well-being [11], [12], [13], and several categories of engineering thriving. For instance, a study investigating the effects of a gratitude meditation intervention found that heart rate decreased during the meditation practice [14]. This suggests that an increased heart rate could lead to lower self-reported gratitude. Another study, which measured heart rate during problem-solving, found an increase in heart rate during the process and a sharp increase once the problem was solved [15]. Further studies have indicated that a lower resting heart rate is associated with higher self-efficacy in exercise programs [16], [17], which informs the prediction that increased intensity minutes (exercise) will enhance self-efficacy. Similarly, a study on college students found that increased aerobic exercise (which reduces resting heart rate) led to higher self-efficacy scores, regardless of exercise history [18]. Although we plan to check for multicollinearity between heart rate and intensity minutes, this study predicts that these variables will influence different thriving categories, as shown in Table 1.

The next biometric indicator under examination is the daily step count. Interestingly, current research indicates that no relationship exists between thriving and step count. Previous studies have used step count as a metric to correlate physical activity with well-being [19], [8]. However, no relevant literature identifies a relationship between step count and the 10 previously identified engineering thriving categories (see Table 1). One study found no increase in self-efficacy from an increase in step count [20]. A study investigating gratitude in college students through an exercise-based intervention also found no significant increase in gratitude from increased step count, though participants with higher gratitude experienced better sleep [21]. Another study found a correlation between baseline optimism and step count, but no link to gratitude [22]. While there is research showing connections between step count and well-being or mental health [23], no studies directly associate step count with the 10 engineering thriving categories. If any information emerges on a potential relationship between step count and any of the thriving categories, we will be able to pivot and analyze this data because the Garmin device will capture this data throughout the study regardless.

Sleep has been widely studied in relation to the well-being of college students. A study in Portugal found that poor sleep habits were linked to lower academic performance and mental health [24]. A German study also found that students with insomnia had lower self-efficacy, suggesting that more sleep may increase self-efficacy [25]. Research on the relationship between sleep duration and problem-solving is less conclusive. One study showed that contrary to popular belief, sleep does not improve problem-solving directly; rather, periods away from the problem aid in solving it [26]. Another study found that sleep deprivation negatively affected communication tasks, resulting in poorer performance among participants who had not slept the night before [27]. Given that poor communication may lead to lower self-reported communication scores, we predict that more sleep will improve self-reported communication. A study on the relationship between gratitude and sleep showed that participants who slept more had higher gratitude scores and wrote more detailed gratitude lists [28]. Research on “long” versus “short” sleepers also suggests that those who sleep less are less open-minded [29], so we predict that increased sleep will correspond with higher open-mindedness responses.

Intensity minutes, a Garmin biometric, measure the duration of exercise activities such as running or brisk walking, detected by the Garmin device [30]. Aerobic exercise research supports

the use of intensity minutes in studying well-being. It is well-established that physical exercise positively affects psychological well-being [31]. For instance, a study on problem-solving confidence found that students who exercised regularly had higher self-confidence when solving problems [32]. A study on self-efficacy in exercise also showed that belief in one's ability to engage in physical activity significantly predicted perceived wellness [33]. Furthermore, exercise has been linked to higher self-care, gratitude, and increased physical activity, showing a positive feedback loop between exercise and these traits [34], [35].

Expected Relationships Between Biometric Markers and Dimensions of Thriving

After reviewing relevant literature, the focus of the study will be on evaluating the relationships between eight of the thriving categories and three biometric variables (Table 1). In Table 1, cells are left blank and shaded grey if no relationships have been identified in the literature, but this does not rule out the possibility of discovering new correlations. The +/- signs indicate a predicted increase or decrease based on an increase in a specific biometric. For example, the negative sign in front of the [14] in the resting heart rate/gratitude cell means that based on the reviewed literature referenced an increase in resting heart rate is expected to decrease gratitude levels. The asterisk denotes a potential relationship without a clear prediction of influence. These complex relationships suggest that an inverse relationship may sometimes exist. For example, intrinsic motivation and time management can influence exercise levels, which is outside the scope of this study but may provide additional insights [31], [36]. This motivates a comprehensive exploration of the data, ensuring that all possible relationships are considered (including non-monotonic relationships).

*Table 1: Predicted relationships. ± indicates positive or negative relationship with increase in the biometric variable. * Indicates that there is an established relationship but no predicted influence on that thriving category from that biometric.*

Thriving Category	Biometrics		
	Resting Heart Rate	Sleep	Intensity Minutes (Exercise)
Problem-Solving	+[15]		+[32]
Communication		+[27]	
Self-Efficacy	*-[16], [17], [18]*	+[25]	+[16], [17], [18],[34]
Self-Care			+[37]
Time Management			*[36]
Gratitude	*-[14]*	+[21], [28]	*[35], [36]
Open-Mindedness		+[29]	
Intrinsic Motivation			*[31]
Welcoming			
Epistemic Curiosity			

Limitations

There are natural risks and limitations associated with pursuing novel research in engineering education. First, there are only a few studies that have attempted to use biometric indicators and survey questions to find relationships between psychological and physiological experiences. This has made designing the study and planning for the analysis of the data that will be collected challenging. Secondly, when the study is executed another limitation is the amount of

data that will be collected as well as the different types of data. For example, Garmin smartwatches continuously capture data while the survey may only take place a few times. This will lead to thousands of biometric measurements per participant and possibly only a few dozen measurements of survey data per participant. The discrepancy in the amount of data and the type of data (quantitative and qualitative) will create difficulty in data collection, data analysis, and in the interpretation of the data analysis.

There are several factors that are not measured by smartwatches that could influence survey responses and biometric data. Those include but are not limited to, diet, number of classes, lifestyle choices, personal life events, health conditions, home environment, community, and much more. With any study, there are an abundant number of factors that are uncontrollable or entirely impossible to measure. We are aware of the most likely factors that could influence the data and regardless of this limitation, we will continue to revise our methods upon current research and successful practices.

Conclusion

The main purpose of sharing this high-level concept paper now is to solicit feedback from the experts in Military and Veteran education on our rationale and begin identifying potential collaborators for our long-term goal of expanding the study beyond Embry-Riddle Aeronautical University. Sharing our ideas and background research prior to the study design and implementation will give us crucial feedback and insight that will help shape our methods and study design. The specific methodology for this study is still being researched and discussed and is not ready to be presented for feedback. Although this specific paper is to highlight the literature review completed to build this study, feedback on the suggested methodology for this study is most welcome and would be greatly appreciated. Feedback that aids in a solution to the issue of data analysis when combining two different types of data as mentioned in the limitations section would also be beneficial.

The expected outcomes of this study include answering our research question in discovering the strongest indicators of thriving in undergraduate veteran engineering students and informing interventions to increase thriving in this population. In addition to these outcomes, there are many benefits to conducting this study such as bringing together a veteran community on campus (via the study) and potentially multiple campuses, encouraging research amongst undergraduate students and amongst the veteran student community, and inspiring new approaches to engineering education research.

Our long-term goal is to improve the diversity of the STEM workforce by enhancing veteran student thriving. Because of the overlap between veterans and other underserved groups, we expect these results to shift the narrative to more thriving models in engineering education as a whole. Increased retention and graduation of veteran students will directly impact society by providing additional members of America's workforce with a unique perspective on the challenges facing America. Finally, we seek to shift narratives of engineering veteran students from 'surviving' to 'thriving.'

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