



## Goal setting as a means of improved mental health outcomes for materials and mechanical engineering students

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# Self-Efficacy and Mental Wellness Goals in Materials Engineering and Mechanical Engineering Students

## Abstract

The mental well-being of undergraduate students is a growing concern among engineering programs. A recent study at a large public institution in the West found that 38% of engineering students who responded to a mental health survey (n~700) screened as high risk of serious mental illness. When broken down by major, 25% of the materials engineering student respondents were at high risk, and 28% of the mechanical engineering student respondents were at high risk, compared to 38% for the overall engineering population. To address this problem, we designed a study to understand the mental wellness goals important to materials engineering and mechanical engineering students. This study sought to answer the following questions: 1) what types of goals, related to mental well-being, are important to materials engineering and mechanical engineering students and 2) does incorporating a mental wellbeing assignment improve students' generalized self-efficacy beliefs? Our results indicate that participants' mental health goals centered around eight areas and focused on aspects of physical health such as sleep and exercise. While we did not observe a statistically significant increase in self-efficacy with the mental health action plan assignment, students with lower initial self-efficacy scores showed bigger increases compared to students with higher initial self-efficacy scores. This result suggests that these types of assignments may preferentially benefit students with low self-efficacy.

## Background

There is a growing concern about the mental wellness of undergraduate engineering students. A recent preliminary study at a large public institution on the pacific central coast found that 38% of engineering students who responded to a mental health survey (n > 700) screened as high risk of serious mental illness, including anxiety, depression, panic disorder, eating disorders, and drug and alcohol abuse [1]. When broken down by major, 25% of these high-risk respondents were from materials engineering, and 28% were from mechanical engineering.

Although there are resources on campus to help students with their mental wellbeing, major-specific courses are where students first learn the norms of their discipline's culture, which could include an unhealthy work-life balance that can lead to increased mental health risks. Those of us who want to address this big-picture problem would benefit from knowing, in more specificity, the types of mental wellness goals students find important, as well as their preferred goal-achievement strategies. Knowing these will help faculty and staff be more pro-active in supporting their students. For example, if a salient mental wellness goal is to reduce general anxiety through strategies related to better time-management, instructors may implement a time-management lesson into existing curricula or use policies such as extra credit for submitting completed assignments early.

We broadly define mental wellness to be a state of wellbeing in which students are generally happy, healthy, and involved and engaged with multiple aspects of their lives. Students are able to deal with the inevitable stresses of life, using positive coping strategies, and are able to find and maintain a sustainable work-life balance. While mental wellness has been extensively studied in populations of different ages and backgrounds[2], studies on mental wellness in undergraduate engineering students are relatively scarce. This study will contribute to the engineering education literature by providing a description of the types of mental wellness goals that are important to materials engineering and mechanical engineering students.

Within research on mental wellness, there appears to be a link between mental wellness and self-efficacy [3]–[9]. Self-efficacy has been conceptualized as a set of beliefs that people have about our own abilities to meet challenges and successfully complete tasks[10]. It is important to study self-efficacy in engineering as it has consistently been found to predict academic performance [11], [12] and career choice [13], [14]. Self-efficacy has been studied as both a task-specific set of beliefs (e.g., academic self-efficacy) [12], [15]–[19] or as a task-general set of beliefs (e.g., generalized self-efficacy) [10], [20]. In this study, we chose to use Sherer et al’s generalized self-efficacy scale due to the open-ended nature of the mental health assignment used in the study. Additionally, some researchers suggest that improving generalized self-efficacy will also increase task-specific self-efficacy [10], [21].

According to Sherer et al, generalized self-efficacy is “a general set of [self-efficacy] expectations that the individual carries into new situations” [10]. The authors expected that working on their mental health would involve several new situations for students, which made this generalized self-efficacy scale seem more appropriate for use in the study than task-specific self-efficacy scales. While self-efficacy has been studied in the context of mental health, it has thus far not been used to study mental health of engineering students to the authors’ knowledge.

## **Research questions**

The purpose of our study is to explore the types of goals related to mental wellness that are important to engineering students and to identify changes in self-efficacy associated with engaging in activities related to improving mental wellness. Based on the above motivation and the gaps in the literature, we designed the study to answer two research questions:

- 1) What types of goals, related to mental wellbeing, are important to materials engineering and mechanical engineering students?
- 2) Does incorporating a mental wellbeing assignment improve students’ generalized self-efficacy beliefs?

## **Methods**

### **Subject characteristics**

Research subjects were recruited from two classes in the Mechanical Engineering and Materials Engineering Departments (ME234: Philosophy of Design, and MATE 232: Materials, Ethics,

and Society). Out of the 37 students enrolled in ME234, eight students opted to participate in the study. Out of the 42 students enrolled in MATE 232, 35 students opted to participate in the study with 19 completing all parts of the study. Participation in the study was voluntary, and no extra credit was awarded for participation.

Demographic characteristics of the 27 students who participated in the study are shown in Figures 1 and 2. The dominant demographic was white male from middle income families. Most students did not transfer from another institution or community college, and most students were not the first in their families to attend college.

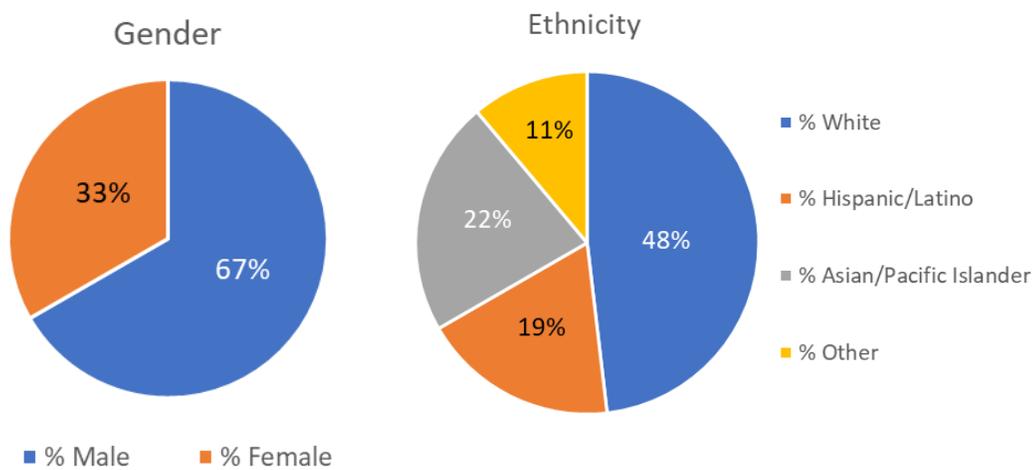


Figure 1: Gender and Ethnicity Demographics of Study Participants

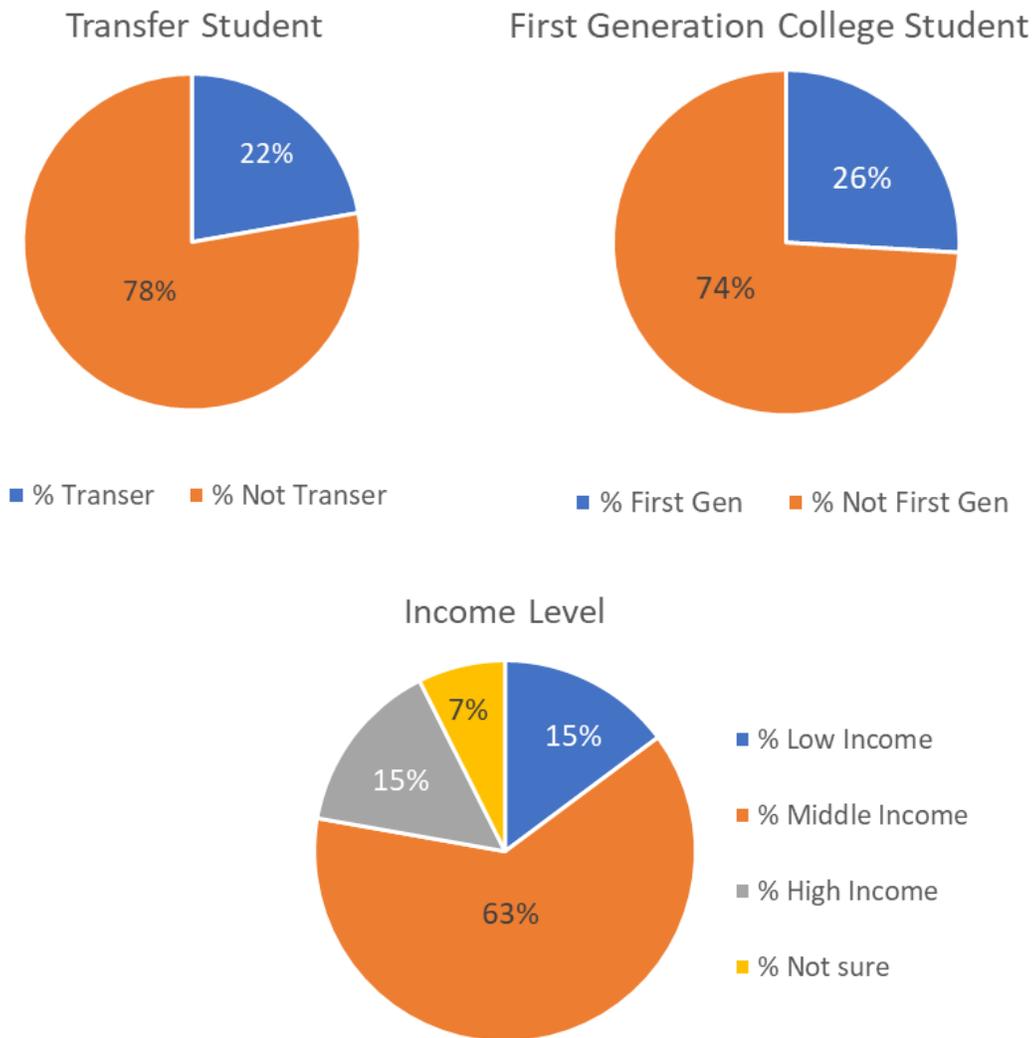


Figure 2: Income, Transfer and First-Generation Demographics of Study Participants

### Data collection and analysis

We used a mixed-methods research design, combining quantitative and qualitative methods. Quantitative methods consisted of pre- and post- course surveys to measure changes in students' levels of self-efficacy beliefs. Self-efficacy was measured with a 17-item validated instrument commonly used to measure general self-efficacy [22]. We used the Shapiro-Wilks test to verify the normality of the data before conducting a paired t-test to determine the effect of the action plan assignment on students' self-efficacy. We used a p value of 0.05 as our basis for statistical significance for both tests. In our survey, we also included six demographics questions such as ethnicity, gender, socio-economic status, transfer student status, and employment status.

Qualitative methods consisted of a content analysis of the students' finalized "Action Plan for Mental Wellness" assignment (see study context below) as well as students' responses to the free-response questions on the post-course survey:

Overall, how successful do you feel you were at working toward your goal? Did you surpass or fall short of your own expectations? Has working toward your goal had a positive impact on any other areas of your life? What have you learned from this goal-setting experience that you might apply in the future?

The overarching goal of the content analysis was to determine the types of mental wellness goals students find important, and to determine some potential connections between students' self-efficacy beliefs and their success at achieving personal goals.

### **Study context**

All students in both ME234 and MATE 232 completed an ongoing "Action Plan for Mental Wellness" assignment over a period of eight weeks. An action plan is a sequence of steps that must be taken, or activities that must be performed, for a goal to be realized. The action plan assignment has five major elements:

- Overall goal
- Measurable tasks
- Timeline
- Rewards
- Progress log

The assignment prompted students to first select a big-picture goal related to mental wellness that they wanted to work toward. Goals suggested to students included increasing exercise, improving eating habits, getting more regular sleep, joining a club, learning relaxation techniques, etc. Students were allowed to choose any goal for the assignment so long as it related to mental wellness and was realistic to make progress toward during the subsequent eight weeks. Students were free to choose any mental-wellness related goal; we expected students would choose goals related to time management, sleep, exercise, personal time, relationships, etc. However, as stated above, the types of goals students find important is one of the questions this study aims to answer.

Students were then instructed to split up their big-picture goal into several manageable and measurable tasks, then assign deadlines for each task. Lastly, it was recommended (but not required) that students assign a reward to each deadline. A modest purchase, an outing with friends, or extra time doing something the student enjoys are all types of reasonable rewards. Below is a simple instructor-developed action plan that was shown to the students to help them get started. An example of a student-developed action plan is in Appendix A.



Figure 3: Instructor-developed Action Plan Example for Students

Once students submitted their Action Plans and received instructor feedback, students began to enact their plan. Along the way, instructors offered students encouraging comments and resources that might be helpful. For example, one student's Action Plan involved stress reduction through playing music, and part of her Action Plan was to find an inexpensive piano. The instructor sent this student several listings of free pianos in the community, and the student was able to procure the piano and fulfill the rest of her plan. In this way, the Action Plans also helped develop and deepen the personal relationships between students and instructors.

## Results and discussion

### **Research question 1: what types of goals, related to mental wellbeing, are important to materials engineering and mechanical engineering students?**

Upon reviewing the finalized action plans, students' goals fell into one of eight categories: exercise, health, hobby, sleep, time management, grades, self-care, and social. A distribution of the number of action plans per category is shown in Figure 4. The specific goals are listed by category in Table 1.

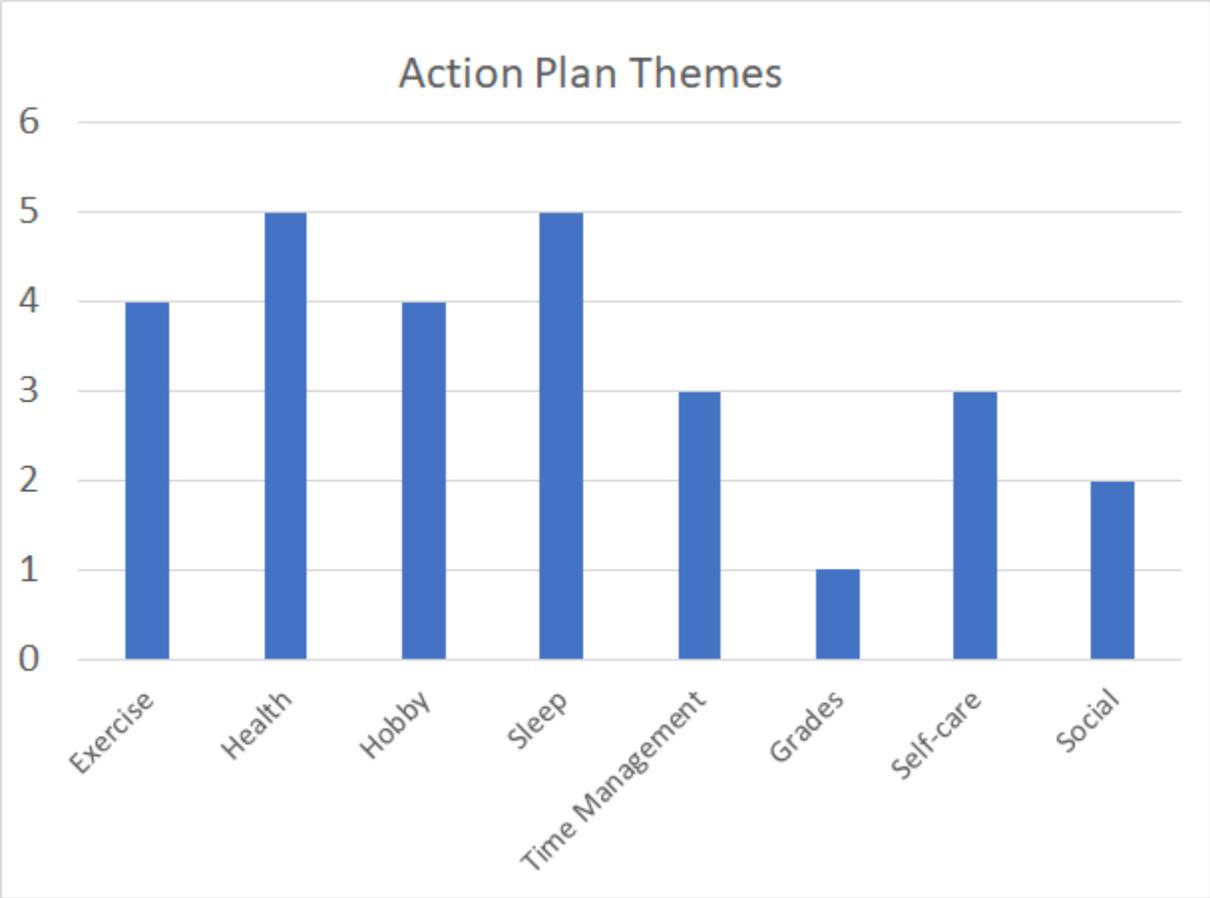


Figure 4: Action Plan Themes by Student

Table 1: Action Plan Themes and Activities. Action plans created by students who demonstrated large increases in self-efficacy are presented in bold font.

<b>Time Management</b>	<b>Grades</b>	<b>Self-care</b>	<b>Social</b>
Have better time management by creating achievable schedules	Keep my grade	Journal my thoughts nightly to keep my ideas and feelings straight	<b>Feel happier and less socially anxious through more frequent interaction with more and new people</b>
		<b>Work out an effective means of prioritizing responsibilities and self-care</b>	Manage my time more efficiently so that I have more time to be able to form and build stronger relationships with as many people as possible.
		Limit negative self-talk	
		Reduce screen time	
<b>Exercise</b>	<b>Health</b>	<b>Hobby</b>	<b>Sleep</b>
Establish a consistent exercise routine	Lose enough weight to drop down another pant size or two by the end of the quarter	Learn the foundations of how to make a website and start developing a prototype	<b>Ease my anxiety by getting good sleep each night</b>
Attend the gym 5 days a week to take a healthy break and stay fit.	Unclear but looks to be related to eating healthy	Lower stress by having time designated to not do schoolwork	Drink water, REM sleep, breaks, reduce blue light
Relax Mind and body using yoga and stretching	<b>Work on general health</b>	Lower stress buildup throughout the week by actively taking time to relax throughout the day and doing something active/fun once or twice a week	Improving mood through getting adequate sleep most nights
Complete at least 3 physical activities a week.	Work towards a healthier lifestyle in regards to nutrition, sleep, and exercise	Learn a song on guitar	Get to bed at a regular time
	Create a health checklist to manage my anxiety and depression symptoms		

Analysis of free-response survey item revealed some patterns across students. Five of the twenty-five students said they were very successful, accomplishing every aspect of their goal. Five of the twenty-five students said they were unsuccessful in achieving their goal. The remaining

fifteen students said they were only partially successful in achieving their goal. Students expressed that it was difficult to “stay on track” when they got sick, when midterm season hit, and when other unforeseen circumstances popped up.

“I was doing great but then I got derailed by the break and had a hard time getting back on track. I found that it’s best to set a good pattern early and keep it going.

“I didn’t feel too successful because my quarter was a lot more difficult than I thought it would be. Finding time to work on something extracurricular was not a frequent option.”

However, eighteen of the twenty-five students expressed that working toward their goal had at least some positive impact on other areas of their life:

“Working towards my goal helped my self-confidence and my mental health in general. I have learned how important planning is and using a pre-planned schedule to get things done. I also learned that I benefit from rewarding myself in some way, no matter how small.”

“Working towards my goal has also positively impacted just my overall mood and day-to-day approach to school and my responsibilities by allowing me to manage my stress and let less negativity effect those areas of my life.”

“Through this I learned how to...not worry as much and to take life in pieces.”

Twelve of the twenty-five students described that they learned the value of setting concrete goals, tracking those goals, and establishing a routine:

“I have learned that quantifying goals helps to achieve them. Abstract goals are often hard to remember to complete. From this experience, I learned that I should track my goals and my progress in the future. This will help me to succeed.”

“I learned that putting my goals into writing helped me work towards completing my goal more consistently.

## **Research question 2: Does incorporating a mental wellbeing assignment improve students’ self-efficacy beliefs?**

The pre-course survey data had a mean score of 121.48 and a standard deviation of 5.02. The post-course survey data had a mean of 125.35 and a standard deviation of 5.02. We used a 1-10 Likert scale versus a 1-14 scale that the original instrument used. We tested the validity of the instrument with the new scale using the Cronbach’s alpha value, which was 0.91 for our instrument, indicating good instrument validity and consistent with other validation studies [20]. Both the pre- and post-course data met the assumption of normality according to the Shapiro-Wilk test ( $p=0.22$  and  $0.54$  for the pre- and post-course data respectively). Because they met the assumption of normality, we were able to use a two-tailed paired t-test to determine the effect of the action plan assignment.

The two-tailed paired t-test on the pre- and post-course data showed no statistically significant difference in self-efficacy scores ( $p=0.48$ ). While the action plan assignment did not result in a statistically significant change in students' self-efficacy, there appears to be a disproportionate benefit for those with an initial self-efficacy score of approximately half or lower of the total possible score (170 for our ten-point scale). Six of the twenty-seven students had noticeable gains or losses in their self-efficacy score as shown in Table 2. Students with gains or losses in self-efficacy of at least five standard deviations are highlighted green or red respectively. All names listed in Table 2 are gender-neutral pseudonyms. Two of the four students who had large gains in their self-efficacy scores scored low on the pre-course survey (score of 85 or lower) with one student close to our definition of low (88 vs 85).

Table 2: Self-efficacy scores from the pre-course survey, post-course survey, and the differences.

Gender-neutral Pseudonym	Self-efficacy Survey Score		
	Pre-course	Post-course	Difference
London	79	123	44
Kendall	80	87	7
Carmen	81	106	25
Skyler	83	93	10
Jordan	88	121	33
Jamie	92	162	70
Morgan	103	123	20
Angel	106	112	6
Riley	110	117	7
Quinn	113	92	-21
Reece	116	128	12
Addison	117	126	9
Leslie	118	103	-15
Eden	123	113	-10
Parker	128	125	-3
Taylor	129	69	-60
Amari	133	134	1
Hayden	135	141	6
Harley	135	159	24
Drew	140	146	6
Blake	144	140	-4
Rory	148	148	0
Payton	150	157	7
Jesse	151	94	-57
Marley	155	143	-12
Tatum	159	150	-9
Blair	164	164	0

## Conclusion

Mental health among engineering students is a growing concern among universities. Our study sought to understand what mental health goals are important to mechanical and materials engineering students and to investigate the roll of self-efficacy in their goal setting. Within our study, students' mental health goals centered around eight areas and seemed to focus on aspects of physical health such as sleep and exercise. While we did not observe a statistically significant increase in self-efficacy with the mental health action plan assignment, there appears to be a bigger benefit for those with self-efficacy scores less than half of the total of the instrument. Together, the data suggest that goal-setting activities in the classroom could have a particularly beneficial impact on students with low self-efficacy while not negatively affecting those with moderate or high self-efficacy.

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**Appendix A: example of finalized student action plan**

