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Exploring changes in metacognition, time management, and wellbeing among gen Z first-year undergraduate engineering students.

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This full paper introduces a larger project exploring how the development of time management and metacognition skills may positively impact the agency of first-year engineering students and their success, which we acknowledge can be measure in traditional ways (e.g. persistence, achievement) and non-traditional ways (e.g. well-being).

The ever-evolving characteristics of college students demand continuous actualization of educational strategies. It is known that most college students nowadays belong to Generation Z, who are technology-natives, ethnically diverse and are on track to become the most educated generation. However, they also struggle the most with their mental health, which is influenced by contemporary challenges such as mass shootings, money and work stressors, the political climate, and stresses and losses derived from learning within a pandemic. If we honor our commitment to support their success, we need to consider these strengths and weaknesses. As well as considering the critical role of well-being in their success.

As part of the project, we collected baseline measures of the constructs of interest in a first-year engineering course at a University in the U.S. East, using established and validated instruments. The measures took place before and after students were provided with formal content about metacognition and time management within the Fall 2024 semester. Paired t-tests comparisons were conducted to evaluate gains in metacognitive and time management skills as well as to explore changes in well-being. Interpretations and implications of our results in the first-year engineering experience are offered.

Introduction

The characteristics and needs of college students have always been changing with time. It is a traditional adage to say that "students are not like they used to be." Such assessment is true, as generational shifts affect the way our students live and learn [1]. The majority of college students nowadays belong to Generation Z, who are technology natives, ethnically diverse, that are on track to become a most educated generation [2]. However, they are also the generation that has struggle the most with their mental health; surveys have documented that their sources of stress leading to such struggles include mass shootings, money and work stressors, the political climate and discrimination [3]. Not surprisingly, the COVID-19 pandemic and the racial reckoning in the U.S. has also negatively influenced the mental health of Gen Z's [4], [5], [6, p. 5]. Consequently, for some students coming to college in Fall 2022 it was their first full academic year back in the classrooms and presented unsurmountable cumulative challenges. If we are to serve our students right, we need to consider these restrictions in the design of their educational experiences. Similarly, we believe it is necessary to be open to reframe success in terms beyond academic achievement. For example, considering their wellbeing into the equation, and cherish diverse paths students with different backgrounds and previous opportunities can have to success instead of the conventional "4-year to graduation" pathway.

In the context of the authors' institution, it has been identified that the proportion of students that expect having to work to pay for their college expenses is growing (57% in 2021), in addition, these students are also recognizing having weak time management and organization skills [7]. Instructors and administration are paying attention to the keen needs of the incoming generations of students. It is critical to expand our understanding of our students' characteristics and how specific course redesigns can target the enhancement of student agency, which aligns with students ability to self-regulate [8], and self-monitor [9] their learning. Additionally, there is also an opportunity to reinvent the way that student success is conceived by adding a consideration of student wellbeing as a measure of success.

This study is part of a larger research project aiming to explore the relation between time management and metacognition skills on student agency and subsequent success as measured by traditional metrics such as grades, GPA, and retention, as well as non-traditional approaches to success, like wellbeing. In this paper we focus on exploring the changes on metacognition and time management skills before and after students engaged in course content that was implemented with focus on these topics during the Fall 2025 semester. In addition, we pay attention to measures of wellbeing that have traditionally not been considered as an outcome of interest. Therefore, our research questions are as follows:

1. Which changes are seen in *time management skills* of first-year engineering students before and after engaging in content and discussions on the topic?
2. Which changes are observed in *metacognition skills* of first-year engineering students before and after engaging in content and discussions on the topic?
3. Which changes are observed in the *wellbeing* of first-year engineering students before and after engaging in content and discussions on metacognition and time management?

Background

The transition from high school to college can be overwhelming for first-year students [10]. During the first year, students are also at a higher risk of experiencing academic difficulties and mental health challenges [11]. Consequently, effective first-year support has been shown to increase student retention, academic success, and persistence in engineering programs [12].

First-year students face significant academic hurdles, such as adapting to rigorous coursework and mastering foundational concepts critical to their future success. Studies indicate that many engineering students struggle with self-regulation and organization, leading to suboptimal performance and increased attrition rates [13]. Moreover, first-year students also face mental health issues like stress, anxiety, and depression. Specifically, Generation Z students, comprising the majority of college enrollment, face unique stressors, including the lingering effects of the COVID-19 pandemic [14]. Finally, Jensen and Cross [15] also stated that self-reported stress, depression, and anxiety levels are high among engineering students.

In such environments, metacognition, time management, and wellbeing are important factors that act as mediators for the personal development of first-year engineering students [16]. In the context of engineering education, problem-solving, and self-directed learning are essential to the learning experience of the students. Metacognition enables students to reflect on their approaches to completing complex tasks, thereby improving their academic performance [17]. Moreover, developing effective time management strategies early in the academic journey is crucial for long-term success. For instance, Adams and Blair [18] found that poor time

management can cause stress, lower academic performance, and increased drop-out rates. Finally, stress, anxiety, and mental health issues have been linked to lower academic performance [13], [19]. Consequently, various interventions have been implemented to support the development of metacognition, time management, and wellbeing among first-year students.

Structured academic programs like first-year seminars promote metacognitive development by encouraging students to reflect on their learning strategies and adjust them accordingly [20]. Moreover, Cunningham and colleagues [21] demonstrated that incorporating reflective exercises into engineering curricula improved students' ability to self-regulate and adapt their learning strategies. Additionally, a community of practice was also proposed by [17] to develop a space for researchers focused on metacognition having diverse disciplinary backgrounds to foster a better understanding of the complex concepts of metacognition The idea behind doing that was to encourage metacognition among engineering students. Such interventions have the potential to help students utilize metacognitive techniques that may contribute to their professional and personal development.

Time management interventions typically involve training sessions and workshops focused on goal setting, prioritization, and task scheduling. For instance, [18] developed a time management training program and concluded that the students who actively utilize time management tools like planning, setting goals, and priorities achieve higher academic performance and demonstrate lower stress levels. Another innovative approach is the use of the "Chronos" tool, as outlined by [22]. The tool employs gamification techniques to motivate students to adopt productive habits. Targeted interventions like these can equip first-year students with the skills needed for long-term success.

To support student wellbeing, many universities have implemented mental health services, peer mentorship programs, and wellness initiatives. Strategies such as Mindfulness-Based Stress Reduction (MBSR) programs have shown promise in reducing stress levels and improving mental health outcomes for students [23]. Moreover, another intervention, introduced by [24], enabled first-year engineering students to measure their own biometric data to observe the results of wellness practices. The pilot study of the intervention showed promising results as the students reported its effectiveness. It is important to note that these interventions are most efficient when tailored to the unique needs and challenges of first-year students.

Our study aims to bridge critical gaps in the existing literature by exploring the interconnected roles of metacognition, time management, and wellbeing in first-year engineering students. The study also focuses on the evolving characteristics and unique challenges of Generation Z students, particularly within the context of first-year engineering education. Building on the work of [17], [21], [25], we propose targeted interventions, aimed at fostering a sense of agency among first-year engineering students, with the potential for positive impact in both academic outcomes and broader measures of success tied to wellbeing.

Study Design

The relationships that this study will explore are illustrated in Figure 1, which denotes our general hypotheses, which are: *Time management and metacognition skills will positively impact student agency and result in student success expressed not only as academic achievement and retention but also as improved non-academic outcomes such as wellbeing and knowledge of resources.*

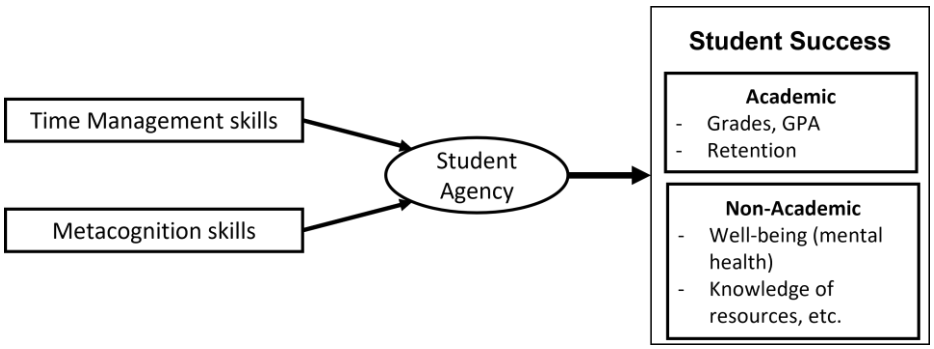

Figure 1. Hypothesized relations for the larger study, in this paper we focus on time management, metacognition, and wellbeing as non-academic student success.

This is an observational quantitative study, as the content in time management, metacognition and wellbeing was already part of the course, and only the measurements of these constructs were implemented in the Fall 2025 semester. The goal of this study was to provide a baseline measure for upcoming innovations that are being part of an externally sponsored project, which will lead to modifications in upcoming years.

Theoretical Framework

The focus of our research is exploring how the use of metacognitive and time management skills can support students' agentic behaviors that influence their success. Where success will be defined as both traditional measures of academic success (e.g. grades, retention); as well as the measurement of achievement of their individual goals, including non-traditional measures, such as those related to wellbeing. To explain the theoretical interactions, we will study the constructs of agency, metacognition and wellbeing.

Agency refers to the ability of individuals to engage in actions that are self-regulated and goal-oriented [26], agentic individuals "plot and navigate a chosen course through the uncertainties and challenges of the social and ecological environments . . . continuously interpreting and evaluating actions and their consequences" [2, p. 390]. Therefore, agency involves both and *self-determination,* or the what to achieve, and *self-regulation,* or the how to achieve it. There are specific theories for these constructs, Deci & Ryan's self-determination theory [28] establishes three components of self-determination to be autonomy, relatedness, and belonginess. In the case of self-regulation, Baumeister, Schmeischel & Vohs [29]; propose that its essential components, are commitment to standards, monitoring of behavior, and capacity for change of behavior, these theoretical elements interact directly to the sense of agency that a learner has to achieve a goal.

Metacognition is known as the knowledge and regulation of our own cognitive processes [30], and involves developing knowledge about cognition, such as that related to people, tasks, and strategies; as well as practice in the regulation of cognition, through the stages of planning, monitoring, controlling, and evaluating cognition [31]. Such conceptual framework of metacognition has been used in a number of recent engineering education research endeavors in recent years [32], [33], [34], [35], [36], [37], [38]. While metacognition could be claimed as a self-regulation strategy, there still needs to be an element that ignites the motivation to engage in such behavior, i.e. the self-determination required for agency.

Wellbeing is defined by the World Health Organization as "not merely the absence of disease or infirmity but a state of complete, physical, mental and social well-being" such multidimensionality is now acknowledged by wellbeing theory which proposes: positive emotion, engagement, relationships, meaning, achievement (PERMA) as ideal predictors of optimal wellbeing (a.k.a. flourishing) [39]. Our study commits to support students' familiarity with such multidimensionality that can strengthen their own understanding of what could work for promoting their wellbeing in their individual case.

Finally, we see ***time management*** as another space where self-regulation and metacognition can is manifested. Because self-regulation is an essential element in agentic behavior. In particular, the time management activities will also provide an opportunity for students to practice and advance their self-regulation skills.

Context

The context of this study was a first-year engineering course at the University at Buffalo. The format of the class is that of a seminar meeting three times a week for lectures that are 50 minutes long, and an accompanying hands-on laboratory that meets for one session of two hours weekly. The size of the first-year engineering cohort in Fall 2024 was about 719 students that were split between 4 sections, each section then was divided into 5 to 6 laboratories of a maximum size of 28 students. Laboratories are led by undergraduate and graduate teaching assistants that have previous experience with the course. Labs are also supported by undergraduate student assistants that help students with the tasks and content at hand.

The demographic distribution of the Fall 2025 cohort for the course was as of 19.8% women and 80.2% male; 19.8% international, and 80.2% domestic; and 25.3% First Generation students.

Established Course Content in Time Management, Metacognition and Wellbeing

Content related to metacognition was discussed during weeks 2,3, and 7. Its discussion followed a flipped-classroom format in which students had to watch videos outside of class followed by a discussion in class about the takeaways of the content of the videos and activities to consolidate the concepts in class. The videos used were previously produced by other researchers [31], [40] and accompanying quizzes were created by the teaching team that students had to take before coming to the corresponding session. For each of the sessions where this topic was discussed, two videos and two quizzes were assigned. In class, reflective questions and think-pair-share discussions were conducted.

Wellbeing and Time Management were topics discussed in the class in Week 2. Time Management was also discussed under the preamble of an existing video previously produced by the University, while wellbeing was discussed in class, linking wellbeing to safety. The general connections between these ideas are presented in the preamble of the professional commitment of engineers to safety, which based on the NCEES definition of safety determines that "Safety is the condition of protecting people from threats or failures that could harm their physical, emotional, occupational, psychological, or financial well-being. Safety is also the control of known threats to attain an acceptable level of risk" [41].

Such definition, and the corresponding responsibility of engineers with safety was then illustrated with specific examples, such as those related to dam collapses, and the Challenger explosion. Then students were exposed to the idea that "To keep others safe & healthy, engineers

first need to keep themselves safe and healthy" connecting this to basic need to keep themselves ok in order to conduct engineering work. Then we introduced the wheel of wellbeing and its different dimensions [42] in a traditional lecture format. Finally, time management was linked as a strategy to procure wellbeing rather than as a way to produce more. In that sense we are intentionally starting conversations that deviate from the traditionally capitalistic approach for time management, which usually focuses on "doing it all and doing it perfectly." We believe such perceptions are non-productive especially to first-year students which are already overwhelmed with the plethora of new challenges they are facing. Therefore, we are intentionally aiming to change the narratives around wellbeing and time management prioritizing a holistic approach for student success.

Two assignments related to time management and wellbeing were also assigned, the first one requiring students to develop a high-level plan for their time management and wellbeing, including evidence of developing a master calendar, and engaging in the reflection about which weeks they expected to be the most challenging in their semester and which strategies they would use in navigating them. In addition, it asked students which strategies they would implement to maintain their physical and mental health. The second assignment was a follow up evaluating how their implementation of their time management and wellbeing plan was going around week 6 of the semester.

Methods

Data Collection

Data was collected through established instruments to measure metacognition skills, time management skills, wellbeing, and agency. A thorough description of each instrument follows.

Metacognition skills were measured through the *Metacognition Awareness Inventory (MAI)*, which is an instrument that has been modified from its original version of 52 items [43] to shortened versions. Recently, the tool has been validated as having two main dimensions, knowledge and regulation of cognition and a 19-item version to have the same differentiation power than the large version [44]. However, some work in engineering education proposed a different shorter version of the MAI with 23 items [37] with not perfect overlapping with the 19-items version; therefore, we opted to use the union of both sets for the execution of this project, which resulted in a total of 33 items so we can execute analyses with both subsets of items and conduct our own validation of structure for the instrument. Questions refer to the use of strategies and habits related to the habits of mind or actions related to knowledge and regulation of cognition (e.g. "I set specific goals before I begin a task"). Responses to the instrument were in Likert scale ranging from (1) never to (5) always. Therefore, total values of this scale range from 34 to 165.

Time Management skills were gauged through the *Time Management Behavior Scale* (TMBS) [45], was used to gauge students time management skills. This tool has been extensively used in previous studies [45], [46], [47], and has shown to be a reliable measure of the construct. It is composed of four dimensions or elements: setting goals and priorities, mechanics and planning scheduling, preference for disorganization, and perceived control of time. The tool has a total of 34 items with responses in Likert scale ranging from (1) never, to (5) always. The original version of this instrument was not accessible, but its published validated version in Spanish [48]

was translated back to English for our study. The range of the total of this scale is between 34 and 170.

Wellbeing in this first stage of the study was measured through three different tools:

- The *HERO wellness scale* is a validated and reliable instrument to gauge a person wellness [49] based on 5 items, which asks respondents how much of an emotion they have experienced on average during the last 7 days. These emotions are happiness, enthusiasm, resilience, optimism. As well it includes a self-evaluation question that asks how they rate their mental health in the same 7-day period. Responses can vary from 1 (not at all) to 10 (extremely). Therefore, its values range from 10 to 50 with higher values indicating higher levels of wellness.
- The *WHO-5 Well-being Index* is a set of 5 questions asking participants an assessment of how often they experienced a specific feeling related to positive wellbeing during the last two weeks (e.g. "I have felt cheerful and in good spirits") which aims to gauge general wellbeing. Responses can vary from 0 (at no time) to 5 (all of the time), for a total between 0 to 25 with higher values indicating higher levels of wellbeing.
- We used the *Depression, Anxiety, and Stress Scale* (DASS-12), which is the shortest validated version (12 items), that gauges a real-time measurement of such mental conditions by asking participants how certain experiences applied to them [50]. The scale has 4 items per condition, and its responses go from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time) therefore its totals for each sub-construct range between 0 and 12, with higher values meaning higher levels of each condition.

Student agency was measured through the *Academic Commitment Scale* (ACS), derived from the academic commitment model developed by [51], [52], and translated from French for such work. It is composed of 14 items measuring three subconstructs: a motivational, a behavioral, and a cognitive component to academic commitment. An example of the cognitive component is "I am perfectly comfortable with the fact that studies such as mine may involve certain difficulties" and responses varying between (1) Does not characterize me at all to (8) Characterizes me completely. Therefore, its total ranges between 14 and 132.

Furthermore, demographic data was collected from institutional records to which the investigators have access to. At the beginning of the semester students took a baseline measurement of all these constructs taking the instruments through an online survey system. The second measure of these constructs took place in week 9 of the semester. There was a third measure of these constructs taking place in week 15 of the semester, but that measure is not included in the analysis presented in this paper.

Since all surveys were included as part of the course assignments, and students were given credit for them, the IRB was approved to request student approval to use their data for research at the end of the semester. In a session in week 14 of the semester, students were provided with the written informed consent form which included the information corresponding to the large project and asked for consent to use their class data. From the 716 students, a total of 359 students (49.9% of all students) filled the consent form and only 218 (60.7% of those filling the consent) agreed to the use of their data, which is the data used for this analysis. While all the data will be used for class assessment purposes, only the subset of those consenting will be used for publications like this one.

Data Analysis

Data was cleaned by removing incomplete responses, then verified for consistency in the direction of the values used. General statistics for the scale were calculated for each of the time points separately. Then, the two time points measured for each construct were compared using paired t-tests to explore any significant changes before and after the content on the three topics was discussed during the corresponding sessions.

The analysis was conducted using data from 150 students which had observations at both time points and consented to their data to be used. Paired t-tests were conducted testing the hypothesis of difference between the means at baseline and the mean at Week 8. All statistical tests were performed at the 95% confidence level. Analyses were performed in R.

Results

Table 1 presents the general means at each of the constructs under analysis at both time points as well as the p-value for the two-sided paired t-test of means between both time points.

Table 1. Means at both timepoints for each instrument and p-values resulting from their paired t-tests.

Construct of Interest	***Tool***	***Mean (StDev) at Baseline***	***Mean (StDev) at Week 8***	***P-value***
Metacognition Skills	MAI	128.44 (14.57)	130.84 (16.02)	0.02
Time Management Skills	TMBS	107.12 (13.14)	108.39 (13.88)	0.21
Wellbeing	HERO	25.42 (5.01)	16.3 (3.75)	<0.01
	WHO-5	17.71 (3.18)	16.88 (3.10)	<0.01
	DASS-12	18.6 (5.87)	19.32 (5.77)	0.11
Agency	ACS	94.81 (15.23)	94.73 (16.12)	0.93

Metacognition skills, as measured by the MAI, showed a slight increase across the full sample. While the increase was modest, it was statistically significant

Time Management skills, as measured by the TMBS increased slightly between both time points, however the increase was not statistically significant.

Measures of Wellbeing were the most contrasting with serious losses in the HERO scale, which were statistically significant. Losses in the measures made through the WHO-5 instrument were smaller but also statistically significant. Measures of the DASS-12 showed an increase in depression, anxiety and stress, although not statistically significant.

Finally, the scores on student agency using the ACS, showed very similar results at both timepoints, and therefore their difference was not statistically significant.

Discussion and Future Work

The gains observed in metacognition skills are in line with what could have been expected as an outcome from exposure to the defined content in metacognition and contributes to further evidence that small interventions in this space can support student gains in this area [31]. While the gains were statistically significant their effect size is modest, as the difference in means was small, therefore it would be worth exploring which level of engagement with the presented material would increase such outcomes. The teaching team recognized that the content was not formally integrated within the other tasks students dealt with throughout the semester; wasting an opportunity for deliberate distributed practice [53] of metacognitive skills. In the next iteration of the seminar in Fall 2025 attention will be paid to such opportunities to provide continuous spaces for students to engage in the different stages of metacognitive thinking.

While time management skills showed an increase it was not statistically significant, which brings questions about the usefulness of the current content and its real impact in students. One of the challenges in this area is that strategies for time management tend to be quite personal and what works for one student might not work for another [54]. As a result, the exercises we require from students might not be as diverse as needed. Future work on this space will include the exploration of the subconstructs that the TMBS is measuring, to see if any of these areas showed differential trends. Something that has been observed through the cohorts of this seminar is that those that often need more support building a structure for their work and improving their time management strategies tend to be students with marginalized identities. Exploring this data by demographics will also provide additional insights into which groups benefited the most or which groups did not benefit at all.

In terms of wellbeing, the decrease in the HERO and WHO-5 scales in tandem with the increase in the DASS-12 reflect somewhat expected results, as students are expected to be less stressed at the beginning of the semester. In addition, in the institution under analysis week 8 tends to be among the busiest of the semester as is one in which many midterms are scheduled. It will be critical to expand our understanding to differentiate between how much of these losses are normal changes due to expected periods of manageable stress, and how much of that is due to extraneous demands that they students are being subjected and have been now recognized to be problematic in the culture of engineering [55].

Another extension in our study of wellbeing is to integrate the PERMA tool, which is based in the PERMA framework which acknowledge multiple dimensions of wellbeing [56] and do not hyperfocus on positive emotions as the HERO and WHO-5 do.

Finally, there were no changes in student agency as measured by the ACS, additional exploration of differences within specific groups, such as students from marginalized groups would be critical to enhance our understanding of this construct within this group of students. In addition, future work on this project involves interventions that are aiming to influence student agency, such as the possible selves [57], therefore, it would be critical to also consider if the tool is the most adequate to capture what we are aiming to capture.

Other extensions of this work include the use of a third datapoint that we collected during the Fall 2024 semester and iterate with a strengthened data collection plan in Fall 2025.

Conclusion

This study described a two timepoint comparison of metacognition and time management skills, wellbeing and agency among students in a First-Year seminar at the US East. The two timepoints (week 1 and week 8) were before and after engaging in content related to those topics. Our results confirm significant gains in metacognition skills, but not significant in time management skills. It also showed significant loses in wellbeing which raise questions about the sources of such dip. Agency did not change between both timepoints. Further analysis is needed to expand on the nuances of each construct as well as within subgroups on our sample. Our results will support the strengthening of the corresponding seminar and inform the design of upcoming interventions targeting gains in student agency for holistic academic success.

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References

[1] M. L. Springer and K. Newton, “Gen Y (Millennial) and Gen Z Cultural Cohort Demographics: Social, Political and Economic Perspectives and Implications,” presented at the 2020 ASEE Virtual Annual Conference Content Access, Jun. 2020. Accessed: Nov. 07, 2022. [Online]. Available: https://peer.asee.org/gen-y-millennial-and-gen-z-cultural-cohort-demographics-social-political-and-economic-perspectives-and-implications

[2] A. D. M.D, “Gen Ztressed: A New Generation of College Students,” TimelyMD. Accessed: Nov. 07, 2022. [Online]. Available: https://timely.md/blog/generation-z-college-students/

[3] “Gen Z more likely to report mental health concerns,” https://www.apa.org. Accessed: Nov. 07, 2022. [Online]. Available: https://www.apa.org/monitor/2019/01/gen-z

[4] A. A. Adams-Clark and J. J. Freyd, “COVID-19-related institutional betrayal associated with trauma symptoms among undergraduate students,” *PLOS ONE*, vol. 16, no. 10, p. e0258294, Oct. 2021, doi: 10.1371/journal.pone.0258294.

[5] D. Courtney, P. Watson, M. Battaglia, B. H. Mulsant, and P. Szatmari, “COVID-19 Impacts on Child and Youth Anxiety and Depression: Challenges and Opportunities,” *Can. J. Psychiatry*, vol. 65, no. 10, pp. 688–691, Oct. 2020, doi: 10.1177/0706743720935646.

[6] “Part 1 of 5: COVID-19 Impact on College Student Mental Health.” Accessed: Nov. 07, 2022. [Online]. Available: https://ccmh.psu.edu/index.php%3Foption%3Dcom_dailyplanetblog%26view%3Dentry%26year%3D2021%26month%3D02%26day%3D01%26id%3D9:part-1-of-5-covid-19-s-impact-on-college-student-mental-health

[7] A. M. Bisantz, “Undergraduate Education - University at Buffalo,” Fall 2022.
[8] P. A. Hall and G. T. Fong, “Temporal self-regulation theory: A model for individual health behavior,” *Health Psychol. Rev.*, vol. 1, no. 1, pp. 6–52, Mar. 2007, doi: 10.1080/17437190701492437.
[9] A. B. H. de Bruin and T. van Gog, “Improving self-monitoring and self-regulation: From cognitive psychology to the classroom,” *Learn. Instr.*, vol. 22, no. 4, pp. 245–252, Aug. 2012, doi: 10.1016/j.learninstruc.2012.01.003.
[10] D. E. Reed and G. Z. Jones, “The Importance of First Semester Seminars for At-Risk First-Year Students: Analysis of Student Skills and Time Spent on Class Preparation,” *Educ. Sci.*, vol. 11, no. 9, p. 510, Sep. 2021, doi: 10.3390/educsci11090510.
[11] C. S. Conley, A. C. Kirsch, D. A. Dickson, and F. B. Bryant, “Negotiating the Transition to College: Developmental Trajectories and Gender Differences in Psychological Functioning, Cognitive-Affective Strategies, and Social Well-Being,” *Emerg. Adulthood*, vol. 2, no. 3, pp. 195–210, Sep. 2014, doi: 10.1177/2167696814521808.
[12] G. D. Kuh, T. M. Cruce, R. Shoup, J. Kinzie, and R. M. Gonyea, “Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence,” *J. High. Educ.*, vol. 79, no. 5, pp. 540–563, Sep. 2008, doi: 10.1080/00221546.2008.11772116.
[13] C. Wright, L. Hargis, E. Usher, J. Hammer, S. Wilson, and M. Miller, “Identifying Engineering Students’ Beliefs About Seeking Help for Mental Health Concerns,” in *2021 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual Conference: ASEE Conferences, Jul. 2021, p. 37269. doi: 10.18260/1-2--37269.
[14] S. Wilson, K. Wilder, W. Blackburn-Lynch, J. Hammer, and D. Dailey, “Investigating mental health distress and help-seeking perceptions in first-year engineering students,” in *2022 ASEE Annual Conference & Exposition Proceedings*, Minneapolis, MN: ASEE Conferences, Aug. 2022, p. 40784. doi: 10.18260/1-2--40784.
[15] 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, Apr. 2021, doi: 10.1002/jee.20391.
[16] F. Liu *et al.*, “The Mediating Roles of Time Management and Learning Strategic Approach in the Relationship Between Smartphone Addiction and Academic Procrastination,” *Psychol. Res. Behav. Manag.*, vol. Volume 15, pp. 2639–2648, Sep. 2022, doi: 10.2147/PRBM.S373095.
[17] R. E. McCord, P. J. Cunningham, H. M. Matusovich, and C. A. Carrico, “Creating a Metacognition Community of Practice: Transforming the Engineering Learning Community,” in *2018 IEEE Frontiers in Education Conference (FIE)*, Oct. 2018, pp. 1–5. doi: 10.1109/FIE.2018.8659318.
[18] R. V. Adams and E. Blair, “Impact of Time Management Behaviors on Undergraduate Engineering Students’ Performance,” *Sage Open*, vol. 9, no. 1, p. 2158244018824506, Jan. 2019, doi: 10.1177/2158244018824506.
[19] M. Asghar, A. Minichiello, and S. Ahmed, “Mental health and wellbeing of undergraduate students in engineering: A systematic literature review,” *J. Eng. Educ.*, vol. 113, no. 4, pp. 1046–1075, Oct. 2024, doi: 10.1002/jee.20574.
[20] P. R. Pintrich, “The Role of Metacognitive Knowledge in Learning, Teaching, and Assessing,” *Theory Pract.*, vol. 41, no. 4, pp. 219–225, Nov. 2002, doi: 10.1207/s15430421tip4104_3.

[21] P. Cunningham, H. Matusovich, C. Venters, S. Blackowski, and S. Bhaduri, “Board 29: The Impact of Metacognitive Instruction on Students’ Conceptions of Learning and their Self-monitoring Behaviors,” in *2018 ASEE Annual Conference & Exposition Proceedings*, Salt Lake City, Utah: ASEE Conferences, Jun. 2018, p. 29999. doi: 10.18260/1-2--29999.
[22] R. Hernandez-Linares, H. Sánchez, J. E. Agudo, and M. Rico, “Chronos: A tool to develop the time management competence among engineering students,” *Comput. Appl. Eng. Educ.*, vol. 25, no. 1, pp. 79–89, Jan. 2017, doi: 10.1002/cae.21780.
[23] M. D. Bamber and J. Kraenzle Schneider, “Mindfulness-based meditation to decrease stress and anxiety in college students: A narrative synthesis of the research,” *Educ. Res. Rev.*, vol. 18, pp. 1–32, May 2016, doi: 10.1016/j.edurev.2015.12.004.
[24] I. Miller, S. Lamer, A. Brougham-Cook, K. J. Jensen, and H. M. Golecki, “Development and Implementation of a Biometrics Device Design Project in an Introductory BME Course to Support Student Wellness,” *Biomed. Eng. Educ.*, vol. 2, no. 1, pp. 75–82, Jan. 2022, doi: 10.1007/s43683-021-00060-1.
[25] R. Hernandez-Linares, H. Sánchez, J. E. Agudo, and M. Rico, “Chronos: A tool to develop the time management competence among engineering students,” *Comput. Appl. Eng. Educ.*, vol. 25, no. 1, pp. 79–89, 2017, doi: 10.1002/cae.21780.
[26] K. A. Shogren, M. L. Wehmeyer, and S. B. Palmer, “Causal Agency Theory,” in *Development of Self-Determination Through the Life-Course*, M. L. Wehmeyer, K. A. Shogren, T. D. Little, and S. J. Lopez, Eds., Dordrecht: Springer Netherlands, 2017, pp. 55–67. doi: 10.1007/978-94-024-1042-6_5.
[27] T. Little, P. H. Hawley, Henrich, and Marsland, “Three views of the agentic self: A developmental synthesis.,” 2002, pp. 389–404.
[28] E. Deci and R. M. Ryan, *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press, 1985.
[29] R. F. Baumeister, B. J. Schmeichel, and K. D. Vohs, “Self-regulation and the executive function: The self as controlling agent,” in *Social psychology: Handbook of basic principles, 2nd ed*, New York, NY, US: The Guilford Press, 2007, pp. 516–539.
[30] J. H. Flavell, “Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry,” *Am. Psychol.*, vol. 34, no. 10, pp. 906–911, Oct. 1979, doi: 10.1037/0003-066X.34.10.906.
[31] P. Cunningham, H. M. Matusovich, D. A. N. Hunter, and R. E. McCord, “Teaching metacognition: Helping engineering students take ownership of their own learning,” in *2015 IEEE Frontiers in Education Conference (FIE)*, Oct. 2015, pp. 1–5. doi: 10.1109/FIE.2015.7344080.
[32] J. Newell, “Developing Metacognitive Engineering Teams,” presented at the 2003 Annual Conference, Jun. 2003, p. 8.406.1-8.406.9. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/developing-metacognitive-engineering-teams
[33] J. Chen, “Effective and Adoptable Metacognitive Tools,” presented at the 2016 ASEE Annual Conference & Exposition, Jun. 2016. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/effective-and-adoptable-metacognitive-tools
[34] S. Krause, “Developing A Method To Measure The Metacognitive Effects,” presented at the 2004 Annual Conference, Jun. 2004, p. 9.397.1-9.397.12. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/developing-a-method-to-measure-the-metacognitive-effects
[35] R. Clark, A. Kaw, and R. Guldiken, “Do Metacognitive Instruction and Repeated Reflection Improve Outcomes?,” presented at the 2022 ASEE Annual Conference & Exposition, Aug.

2022. Accessed: Nov. 08, 2022. [Online]. Available: https://peer.asee.org/do-metacognitive-instruction-and-repeated-reflection-improve-outcomes
[36] E. Valeyeva, R. V. Kupriyanov, N. S. Valeyeva, G. Romanova, and D. R. Nugmanova, "The Role of Metacognitive Skills in Engineering Education," presented at the 2017 ASEE International Forum, Jun. 2017. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/the-role-of-metacognitive-skills-in-engineering-education
[37] M. Dawood, E. Shareef, R. Boren, G. Degardin, M. J. Guynn, and P. Wojahn, "Assessing Metacognition Awareness of Freshmen Engineering Students," presented at the 2021 ASEE Virtual Annual Conference Content Access, Jul. 2021. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/assessing-metacognition-awareness-of-freshmen-engineering-students
[38] O. Lawanto and H. B. Santoso, "Development and Validation of the Engineering Design Metacognitive Questionnaire," presented at the 2014 ASEE Annual Conference & Exposition, Jun. 2014, p. 24.412.1-24.412.11. Accessed: Jul. 10, 2023. [Online]. Available: https://peer.asee.org/development-and-validation-of-the-engineering-design-metacognitive-questionnaire
[39] J. K. Coffey, L. Wray-Lake, D. Mashek, and B. Branand, "A Multi-Study Examination of Well-Being Theory in College and Community Samples," *J. Happiness Stud.*, vol. 17, no. 1, pp. 187–211, Feb. 2016, doi: 10.1007/s10902-014-9590-8.
[40] pjcunningh, "Skillful Learning," Skillful Learning. Accessed: Jan. 15, 2025. [Online]. Available: https://skillful-learning.org/staging/8766/
[41] "About," NCEES. Accessed: Jan. 15, 2025. [Online]. Available: https://ncees.org/about/
[42] "Wheel of Well-being." Accessed: Jan. 15, 2025. [Online]. Available: https://www.wheelofwellbeing.org/
[43] G. Schraw and R. S. Dennison, "Assessing Metacognitive Awareness," *Contemp. Educ. Psychol.*, vol. 19, no. 4, pp. 460–475, Oct. 1994, doi: 10.1006/ceps.1994.1033.
[44] G. M. Harrison and L. M. Vallin, "Evaluating the metacognitive awareness inventory using empirical factor-structure evidence," *Metacognition Learn.*, vol. 13, no. 1, pp. 15–38, Apr. 2018, doi: 10.1007/s11409-017-9176-z.
[45] T. H. Macan, C. Shahani, R. L. Dipboye, and A. P. Phillips, "College students' time management: Correlations with academic performance and stress," *J. Educ. Psychol.*, vol. 82, pp. 760–768, 1990, doi: 10.1037/0022-0663.82.4.760.
[46] R. V. Adams and E. Blair, "Impact of Time Management Behaviors on Undergraduate Engineering Students' Performance," *SAGE Open*, vol. 9, no. 1, p. 2158244018824506, Jan. 2019, doi: 10.1177/2158244018824506.
[47] T. H. Macan, "Time management: Test of a process model," *J. Appl. Psychol.*, vol. 79, pp. 381–391, 1994, doi: 10.1037/0021-9010.79.3.381.
[48] A. Garzón Umerenkova, R. García Ros, and F. Perez, "Estructura factorial y propiedades psicométricas de la Time Management Behavior Scale (TMBS) en población universitaria colombiana. Universitas Psychologica, 16(1), 1-9. http://dx.doi.org/10.11144/Javeriana.upsy16-1.efpp," *ResearchGate*, vol. 16, no. 1, pp. 1–9, 2017, doi: 10.11144/Javeriana.upsy16-1.efpp.
[49] S. Yaklin, R. Jain, S. P. Cole, C. Raison, and D. Rolin, "HERO Wellness Scale: Examining a new mental wellness scale," *Ann. Clin. PSYCHIATRY*, p. 8.

[50] E. G. Chin, “12-Item Depression, Anxiety, And Stress Scales (Dass-12): Associations With Self-Report Measures, A Semi-Strcutured Interview, And Behavioral Tasks,” *Electron. Theses Diss.*, Jan. 2015, [Online]. Available: https://egrove.olemiss.edu/etd/329

[51] A. Brault-Labbé and L. Dubé, “Engagement scolaire, bien-être personnel et autodétermination chez des étudiants à l’université.,” *Can. J. Behav. Sci. Rev. Can. Sci. Comport.*, vol. 42, no. 2, pp. 80–92, Apr. 2010, doi: 10.1037/a0017385.

[52] A. Brault-Labbé and L. Dubé, “‘Mieux comprendre l’engagement psychologique : revue théorique et proposition d’un modèle intégratif,’” *Cah. Int. Psychol. Soc.*, vol. 81, no. 1, pp. 115–131, 2009, doi: 10.3917/cips.081.0115.

[53] K. A. Ericsson, R. T. Krampe, and C. Tesch-Römer, “The role of deliberate practice in the acquisition of expert performance,” *Psychol. Rev.*, vol. 100, no. 3, pp. 363–406, 1993, doi: 10.1037/0033-295X.100.3.363.

[54] A. E. Blandford and T. R. G. Green, “Group and Individual Time Management Tools: What You Get is Not What You Need,” *Pers. Ubiquitous Comput.*, vol. 5, no. 4, pp. 213–230, Dec. 2001, doi: 10.1007/PL00000020.

[55] 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: https://doi.org/10.1002/jee.20391.

[56] S. I. Donaldson, L. E. van Zyl, and S. I. Donaldson, “PERMA+4: A Framework for Work-Related Wellbeing, Performance and Positive Organizational Psychology 2.0,” *Front. Psychol.*, vol. 12, p. 817244, Jan. 2022, doi: 10.3389/fpsyg.2021.817244.

[57] E. Altintas, Y. Karaca, A. Moustafa, and M. El Haj, “Effect of Best Possible Self Intervention on Situational Motivation and Commitment in Academic Context,” *Learn. Motiv.*, vol. 69, p. 101599, Feb. 2020, doi: 10.1016/j.lmot.2019.101599.