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WIP: Approaches to pairing proactive advising and teaching students how to learn

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Introduction

The mission of the Inclusion Diversity Excellence Achievement (IDEA) Engineering Student Center at UC San Diego's Jacobs School of Engineering is to promote equity, community, and success for all engineering students at the University from admission through graduation. The Academic Achievement Program (AAP) originally focused on academic performance (i.e., grades) and is evolving to more fully address the myriad of factors that contribute to the overall success of undergraduate engineering students. The AAP aims to **promote a culture of care** for students' personal well-being and academic success within engineering courses by **providing just-in-time support** and **reinforcing attitudes and habits** that empower students to succeed. This effort can be broken down into three goals: I) promote a multifaceted understanding of factors that influence student success, II) teach learning attitudes and behaviors for effective learning, and III) provide tools to support proactive advising at the classroom level. To reach these goals, we envision instructional teams (typically made up of faculty and teaching assistants) who have the knowledge and tools to proactively provide students with support based on deep understanding of how factors inside and outside the classroom influence learning. Such instructional teams can more effectively improve the learning experience and student outcomes like persistence. We also envision students with attitudes and habits that help them learn effectively and use supporting resources to overcome any challenges they encounter. To achieve these goals, AAP includes three components at various stages of development, implementation, and assessment: 1) the Engineer Your Success Course for undergraduates, 2) Student Support Planning Checklist and community of practice for instructional teams, and 3) content on effective learning strategies for instructional teams. This paper will present a developing conceptual framework that guides these activities, describe each component, present preliminary findings, and discuss potential next steps.

Literature Review

Factors that influence academic success

Individual learning consists of cognitive, metacognitive, and affective components [1] and is a socially-embedded process [2]. Cognitive learning refers to acquiring knowledge at increasing levels of complexity, as in Bloom's Taxonomy [3], and is measured through course assessments (e.g., exams). Metacognition refers to awareness and self-assessment of one's own thinking and abilities [3], and regulation refers to the ability to plan and adjust behaviors accordingly based on that knowledge [4]. Metacognitive and self-regulation strategies can help students be more effective learners. The affective element of learning refers to student attitudes and mindsets that can influence their thinking and behaviors, ultimately impacting their learning and academic performance.

Learning and persistence in higher education, and engineering education specifically, are influenced by many internal and external factors [5], [6], [7]. For example, Geisinger and Raman

[7] identify six factors driving students to leave engineering: classroom and academic climate, grades and conceptual understanding, self-efficacy and self-confidence, high school preparation, interest and career goals, and race and gender. The first three items are fundamental to the classroom experience of learning engineering content and skills, identifying the classroom and learning experience as a key battleground for engineering student persistence. Furthermore, personal challenges can disproportionately affect students from certain communities. A study by UC San Diego Computer Science and Engineering faculty identified four categories of student struggle that were correlated to low outcomes in introductory computer science courses, including personal obligations, lack of sense of belonging, in-class confusion, and lack of confidence [8]. They found that students from underrepresented demographic groups struggled more across all categories. Because of the complex relationships between the internal and external influences on learning, it is important to attend to all of these aspects of the student experience. Fortunately, the engineering classroom is a malleable learning environment in which faculty make decisions that can create a more supportive and relevant environment that better serves and retains students [9].

Teaching that changes thinking and behaviors for learning

Attitudes and thought patterns can influence what learning behaviors students adopt and, therefore, the effectiveness of their learning efforts. For example, the research of Dweck and others focuses on how individuals' theories about themselves, such as having a fixed or growth mindset, can impact their behavior. In particular, differences in this mindset can lead to scenarios in which students with similar skill levels perform differently when faced with challenging learning tasks, as cited in [10]. Moreover, self-efficacy, goal orientation (i.e., mastery, performance-approach, or performance-avoid), metacognition, and self-regulated learning each play different roles in contributing to academic performance [11], [12], [13]. For example, while many studies have shown that self-efficacy predicts academic achievement, it is not sufficient. Hsieh et al. [12] found that some students on academic probation had high self-efficacy while at the same time having a performance-avoidance goal orientation (i.e., avoiding failure motivated and shaped their approach to learning), likely influencing the use of less effective learning and study strategies.

Shaping attitudes and habits can be done through a course that focuses on teaching the concepts and skills, or it can be embedded within the engineering classroom experience. For example, a review of growth mindset approaches identified effective interventions including courses and other learning experiences like workshops, discussions, reflective writing, online tutorials, and course-embedded tutors [10]. Metacognitive strategies are also commonly taught outside the classroom through campus teaching and learning centers. There is an emerging focus on metacognition and self-regulated learning embedded within STEM classrooms [14], [15], [16].

Proactive identification and advising of students

Proactive advising, built on the concept of intrusive advising [17], [18], involves proactively reaching out to students to provide advising and support rather than waiting for students to request it. Proactive advising involves approaching students at the first sign of difficulty to both provide support and to motivate help-seeking behaviors, which can increase retention, especially for students at risk of experiencing struggle [19]. We hypothesize that integrating proactive advising in the classroom will have a more direct impact on academic outcomes in that particular course. Furthermore, research shows that the relationship between faculty and students has an impact on student experience as well as academic performance [20], [21]. We hope that proactive advising by faculty will also have these secondary positive impacts on students that contribute to academic success. Uddin and Johnsonidentified being proactive and tracking progress on grades and attendance early in the term as key elements of advising strategies that can inform faculty-advisor collaborations to support students [22].

Project Approach

The AAP includes three key components 1) the Engineer Your Success study skills course for undergraduates, 2) the Student Support Planning Checklist and community of practice for instructional teams, and 3) content on effective learning strategies for instructional teams. Collectively, these components improve the learning experience and student outcomes by assisting students in building the attitudes and habits to be effective learners and empowering instructional teams with the knowledge and tools to proactively advise and support students. As shown in Figure 1, the three key components of the program, to date, are organized under three categories I) promoting a multifaceted understanding of factors that influence student success, II) providing tools to support proactive advising at the classroom level, and III) teaching learning attitudes and behaviors.

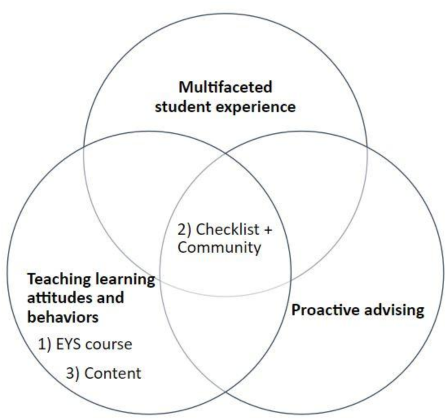

Figure 1: Academic Achievement Program Goals and Implementation To Date

Component 1: Engineer Your Success Course

The Engineer Your Success (EYS) Course introduces students to study, metacognitive, and time management strategies that will help them succeed as engineering students. The course uses content and assignments modified from the textbook *Studying Engineering: A Roadmap to a Rewarding Career* [23]. The course is offered once per quarter during the academic year and during the Summer Engineering Institute (SEI). Close to 300 students have taken the course since spring 2020, with 200 of them having taken it during the SEI summer session. Framed within the context of studying engineering and pursuing an engineering career, key content in the course includes motivations to become an engineer, metacognition and effective learning strategies, and identifying and overcoming attitudes and behaviors that interfere with effective study and time management. The final project in the course is a written paper and oral presentation on how each student will become a “world class engineering student,” taking into account key concepts from the class and reflections on progress towards personal goals in those areas [23, p. 276]. The course is taught by lecturers or graduate student instructors with experience in undergraduate mentorship and teaching. Table 1 provides an overview of the topics and example assignments covered during each lecture.

Table 1: Course Topics & Assignments

Lecture	**Topic**	**Assignments / Activities**
1	Introduction & Course Overview	
2	Keys to Success	Attitudes Survey
3	The Engineering Profession	1-pager on why I want to be an engineer
4	The Teaching-Learning Process	Learning styles assessment / reflection
5	Working Smart	Academic success skills survey
6	Study Management	Academic plan; Plan for improvement
7	Time Management	168-hour log; Priority matrix
8	Personal Assessment and Change	Jung typology test
9	Learning Together	Work on final project
10	Final Project Oral Presentations	Finish final paper

In 2021, the EYS Course was incorporated into the Summer Engineering Institute. Analysis of the SEI pre-post and follow-up surveys provides preliminary evidence that the course enhances growth mindset and acceptance of the need to change study strategies. First, we found that after incorporating the course into SEI, pre-post survey results began showing development of a growth mindset. One of the goals of the SEI program is to develop participants’ attitudes and study habits for success in engineering coursework, such as a growth mindset. However, prior to the addition of the EYS Course into SEI, the 2019 pre-post participant survey showed no development of growth mindset after five weeks of engineering coursework and community building.

The SEI pre-post survey includes growth mindset items modified from existing surveys measuring growth mindset [e.g., 10]. When asked to rate their level of agreement on a 1-5 scale with the statement “Anyone who starts off as an engineering major has the ability to graduate in engineering,” there was no significant difference pre (M=3.82) to post (M=4.03) in 2019 but a statistically significant increase in mean agreement in 2021 (M_{pre}=3.81, M_{post}=4.31) and 2022 (M_{pre}=3.69, M_{post}=4.25) after the course was incorporated into SEI (Wilcoxon Signed Rank, p<0.05). Due to the pandemic, SEI was not offered in its typical configuration in 2020 and the pre-post survey was not conducted. The SEI and EYS Course were then offered remotely in 2021 and in-person in 2022. Interestingly, the increase in growth mindset was consistent across both modalities in 2021 and 2022 when the EYS Course was included in SEI. There were no significant differences during any years on the three other growth mindset items, which are shown in Table 2 below.

Table 2: Growth Mindset pre-to-post change for cohorts 2019, 2021, 2022

Growth Mindset Item	**2019 (n=117)** *No EYS Course, In-person*	**2021 (n=116)** *EYS Course, Remote*	**2022 (n=72)** *EYS Course, In-person*
Anyone who starts off as an engineering major has the ability to graduate in engineering	Pre 3.82 Post 4.03	*Pre 3.81 *Post 4.31	*Pre 3.69 *Post 4.25
Truly smart people do not need to try hard	Pre 1.87 Post 2.07	Pre 1.78 Post 1.65	Pre 1.85 Post 1.82
The harder you work at something, the better you will be at it	Pre 4.57 Post 4.48	Pre 4.41 Post 4.33	Pre 4.37 Post 4.51
Your intelligence is something very basic about you that you can't change very much	Pre 2.03 Post 2.17	Pre 1.85 Post 1.69	Pre 2.01 Post 1.93

Rated on a scale from 1-5 where 1 is "Disagree strongly" and 5 is "Agree strongly"
*Significant difference pre-to-post Wilcoxon Signed Rank, $p<0.05$

Furthermore, preliminary evidence from an end-of-year follow-up survey suggests that the growth mindset initiated during the summer course persists through the end of the first year. At the end of the 2021-2022 academic year, participants from the 2021 cohort took a follow-up survey (n=18) asking the same growth mindset questions. There was a significant difference between pre (M=3.94) and end-of-year scores (M=4.72) and no significant difference between post-SEI (M=4.71) and end-of-year scores (Wilcoxon Signed Rank, $p<0.05$). This suggests that the increase in growth mindset seen after participation in the course during SEI was sustained during the first year of undergraduate engineering study.

Second, the SEI pre-post survey provides preliminary evidence that the course develops a greater acceptance of the need to change study strategies among incoming engineering students. A key lesson for course participants and SEI participants is that they will need new learning and study strategies to succeed as undergraduate engineering students and cannot only rely on their strategies from high school. Acknowledging this opens students to adopting new strategies. When asked about their level of agreement with the statement "I can succeed in college by using the same study strategies I used in high school," SEI participants in 2019 (M_{pre}=3.04, M_{post}=2.72), 2021 (M_{pre}=3.12, M_{post}=1.80), and 2022 (M_{pre}=3.07, M_{post}=1.92) all had a statistically significant shift on this item (Wilcoxon Signed Rank, $p<0.05$). However, while participants from 2019, 2021, and 2022 entered SEI with similar ratings on this item, the size of the pre-to-post change was significantly greater for 2021 and 2022 participants compared to 2019 participants

(Kruskal-Wallis, $p<0.05$), suggesting that participation in the EYS Course contributed to greater impact on this attitude by explicitly addressing the concept. Results are shown in Table 3 below.

Table 3: I can succeed in college by using the same study strategies I used in high school

	2019*	**2021***	**2022***
Pre	3.04	3.12	3.07
Post**	2.72	1.80	1.92

Rated on a scale from 1-5 where 1 is "Disagree strongly" and 5 is "Agree strongly"
*Significant difference pre-to-post each year, Wilcoxon Signed Rank, $p<0.05$
**Significant difference between 2021-2019 and 2022-2019 post scores, Kruskal-Wallis, $p<0.05$

Component 2: Student Support Planning Checklist and Community

The Student Support Planning Checklist (SSPC) is a framework for instructional teams (e.g., faculty and teaching assistants) to define guidelines and identify resources for supporting undergraduate engineering student success in their courses. The framework calls for the:

1. Early detection of students needing academic intervention
2. Early communication with students about their academic performance
3. Referral of students to resources to support their well-being and academic success

The SSPC is divided into seven sections. The first section, **Course Information**, gathers basic course information. Then, in the **Identify and Communicate with Students** section, instructional teams identify the first point in a course where students in need of support can be identified and define the threshold that would trigger communication with the student. For example, some thresholds set by instructors included receiving below a 70% on lab one, missing a homework assignment, or receiving below a 75% on the first exam.

Once criteria for identifying students in need of support are established, the **Tutoring and Other Resources** section asks instructional teams to identify the resources available to support these students. Resources vary based on course and department and could include TA and faculty office hours, course-specific tutors, a department-specific tutoring center, central tutoring services, mental health services, and more. Attending office hours and studying collaboratively are strategies that help all engineering students succeed academically. The **Office, Lab, and Discussion Hours** and **Collaborative Study and Study Groups** sections of the SSPC ask instructional teams to think about how these are implemented and regularly communicated in their courses.

An **Other Supports** section allows instructional teams to document any unique supports. A seventh section, **Effective Learning Strategies**, was added to the SSPC in spring 2022 and will be discussed in detail in the following section on Component 3.

Between spring 2021 and summer 2022 (including four quarters and two summer sessions) the SSPC was used in 58 instances with 41 faculty in 38 unique courses, reaching 6,500 students.

Each quarter, instructional teams first discussed applying the SSPC to their specific courses during an orientation. Then during a mid-quarter meeting, instructional teams discussed challenges and shared effective strategies. Instructional teams valued the opportunity to connect with each other and formed a loose community of practice throughout these meetings. Common challenges to implementing the SSPC were the time commitment to identify and reach out to individual students, getting students to respond when they reached out, and not knowing if students were making use of suggested resources.

Student surveys were typically issued at the end of the quarter to learn about the support students received from their instructional teams and general use of resources. Results varied slightly by quarter, with the number of students who reported receiving communication from their instructors on their academic performance ranging from 20% (spring 2021, n=66) to 43% (spring 2022, n=44). Students who received communication about their academic performance felt more support from the instructional team, had a better sense of how they were doing, and had a better understanding of how to improve in the class than those who did not receive communication. For those students who did receive communication the most common content was regarding a grade on an assignment, quiz or exam, a suggestion to attend office or tutoring hours, or encouraging words. Less common communications shared time management and study strategies and suggested students attend class or discussion more regularly.

Component 3: Content on metacognition and effective learning strategies for instructors

During the spring 2022 quarter, the AAP incorporated content on metacognition and effective learning strategies into the orientation for nine instructors and their TAs. The purpose was to share with instructional teams some of the same content that is taught to students in the EYS Course to broaden the content's reach and impact within the context of their engineering courses. The content was heavily inspired by Dr. Saundra McGuire's *Teach Students How to Learn* [14] and resources available through Louisiana State University's Center for Academic Success [24]. Content included an overview of Bloom's Taxonomy, the study cycle, focused study sessions, and various study, testing, and support strategies to share with students or incorporate into the course.

Instructors were asked to complete the SSPC, which included a new section on empowering students to use **Effective Learning Strategies**. The Effective Learning Strategies section of the SSPC explained that instructional teams were tasked with helping students understand how to study and learn effectively for the course and building opportunities into the course that help students do so. More specifically, the SSPC asked them to identify the most effective study strategies for the course, to describe effective study strategies for one assignment or activity in the course, and describe how the strategies will be communicated to students or integrated into the course structure.

Using the SSPC, nine faculty reported that the most effective ways for students to study for their course was to do practice problems/exams (100%), participate in study groups (72%), review homework (66%), review exams (55%), bring questions to discussion (55%), and preview material before class (44%). When asked to describe these strategies in the context of a specific assignment, faculty provided additional detail on how these are implemented. For example, advising that students do practice problems without looking at the solutions first, encouraging students to start homework early to leave time for questions, or providing time in class to review problem solutions in groups. Instructors planned to reinforce many of the strategies through expectations set in the class, the structure of assignments, and reminders provided during lecture.

An end-of-quarter survey was sent to all 969 students in the participating instructors' courses to learn about support they received from the instructional team and their study strategies. Unfortunately, the response rate was quite low with only 59 responses (6% response rate) and attrition to 35 responses on some items. This reflected a general reduction in capacity for non-essential commitments among students as they returned to in-person learning. Even so, this small sample provides helpful insights. More than half of students (n=37) reported that their instructors and TAs sprinkled learning and study strategies (58%) and test taking strategies (49%) throughout the course. About a third reported learning about the study cycle (33%) and focused study sessions (31%). Only a few mentioned learning about Bloom's Taxonomy from the instructional team (3%). When asked about which study strategies they used for this class (n=38), most students reported doing problems without using examples as a guide (69%). At least half of students reported regularly going to office hours or tutoring (50%), spending at least five days per week studying for the course (55%), and making diagrams about concepts (60%). Students still have room to improve their use of the study cycle. For example, only 24% reported previewing material prior to class and only 37% reported reviewing lecture notes soon after class.

Discussion

Encouraged by early accomplishments with the EYS Course, Student Success Planning Checklist, and content on learning for instructional teams, we envision several areas for further development. First, refining the theoretical framework and alignment between all program components. Second, growing content and resources available for instructional teams on the multitude of factors that influence student academic success, including attitudes that influence learning, metacognition and self-regulated learning, and disproportionate challenges for diverse student groups. Third, enhancing empirical assessment of student attitudes, study habits, academic performance, and course experiences. Fourth, improving proactive advising tools and support for instructional teams, which may include developing diagnostic tools and customized student referrals that address the student experience beyond academic performance. And finally, increasing collaborative content development and assessment with engineering faculty and our campus teaching and learning center to grow a robust instructional community of practice.

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