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# Teaching Learning as a Skill: An Intervention Embedded in a Large Electrical Engineering Course

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## Abstract

Success in engineering requires more than the acquisition of technical knowledge. It also depends on the ability to continue learning and adapting in a rapidly evolving field [1]. While engineering curricula are designed to develop disciplinary expertise, they often treat essential professional competencies, including learning how to learn, as outcomes that will emerge naturally through academic experience. For example, students are expected to become effective communicators by writing lab reports or giving occasional presentations. Similarly, they are assumed to develop strong learning skills simply by working through a demanding curriculum.

However, learning is a skill in its own right [2]. Without explicit instruction, many students rely on strategies developed in high school that are not well suited to the complexity of university-level engineering courses [3, 4, 5]. This gap in learning skills can limit students' ability to fully engage with technical content. More broadly, it may also hinder the development of habits and strategies associated with lifelong learning. Addressing this gap has the potential to support students both in the immediate context of their coursework and in their future professional growth [6].

To explore this challenge, we implemented a series of embedded learning workshops within a large introductory course in electrical engineering. These workshops were designed as an integral part of the course rather than a supplemental or remedial resource. Grounded in research from cognitive science and engineering education, the workshops introduce students to principles of self-regulated learning, growth mindset, and evidence-based study strategies. The sessions are interactive, collaborative, and held during a dedicated second discussion period each week. A key feature of the workshops is the use of examples drawn directly from the course's technical content. By anchoring learning strategies in the context of material students are already studying, the workshops are meant to feel more relevant and immediately applicable. This approach supports better transfer of learning strategies to coursework and also gives students additional opportunities to engage with and deepen their understanding of core technical concepts.


## Introduction

Developing effective learning strategies is a central challenge in engineering education. Many students enter university with study habits shaped by prior experiences that emphasize memorization over conceptual understanding [7]. Recognizing this challenge, educators have explored a variety of interventions designed to help students acquire, apply, and reflect on effective learning strategies. The following sections summarize the main approaches and place our work within this broader context.

### *Standalone Interventions*

A significant number of interventions to develop students' learning skills occur outside disciplinary courses. These standalone efforts include dedicated learning-to-learn courses, academic success programs, and workshops offered through student support centers [8, 9]. They are typically optional. This may cause them to be perceived as remedial, which can reduce participation despite the potential benefits. In addition, research has shown that even high-achieving students often rely on inefficient learning strategies, which further necessitates the need to go beyond interventions that only target a subset of students [4, 5].

Standalone interventions often teach growth mindset, self-regulated learning, and study strategies in a generalized manner, applicable across multiple disciplines. While these programs can be effective in fostering metacognitive awareness and improving study habits, research indicates limitations in achieving transfer to course-specific tasks [10]. Because the instruction is not directly tied to the technical content of a specific course, students may struggle to apply the strategies in context. Nevertheless, standalone approaches remain an important and valuable avenue for supporting students, particularly those seeking additional guidance beyond what is provided in their courses.

### *Course-Integrated Interventions*

Embedding learning skills instruction within the structure of disciplinary courses has emerged as a promising alternative to standalone programs [11]. Course-integrated interventions integrate strategies directly within the technical context and content of a course, which enhances relevance and supports transfer of skills. These interventions have varied widely in scope and duration.

**Targeted-Duration**: Some course-integrated efforts are brief, consisting of single lectures, short instructional sequences, or small embedded assignments. For example, Cook, Kennedy, and McGuire implemented a single 50-minute lecture on metacognitive strategies, followed by brief study sessions [12]. Sandi-Urena, Cooper, and Stevens used a collaborative exercise, based on a brainteaser and the resulting cognitive imbalance, and paired this with take-home assignments and guided feedback [13]. Similarly, Mutambuki et al. introduced metacognitive strategies through a lecture plus a short homework assignment and exam wrappers [14].

These short-duration interventions provided opportunities for reflection and strategy practice without imposing extensive time demands on students or instructors. They have shown to result in positive short-term effects on student study behavior.

**Course-Term-Duration**: Longer-term course-integrated interventions span multiple weeks or an entire term, offering repeated opportunities for practice, reflection, and application. Santangelo, Cadieux, and Zapata integrated fifteen minutes of explicit metacognitive instruction into each of the first six lectures of a flipped classroom, complemented by reflection triggers and activities linked to course content [15]. Peuker and Landis created the “Design Your Process” program, in which students reflect on the practices required to become a world class engineer [16]. This program consisted of 7.5 hours of structured activities, producing both immediate and lasting improvements in learning strategies. Term-long interventions have also been implemented in large courses. Gamby and Bauer introduced weekly modules in a chemistry course that addressed student beliefs, taught metacognition, and prompted both individual and collaborative reflection [17]. Similarly, Graham, Bohn-Gettler, and Raigoza conducted twelve tutoring sessions for a large chemistry class, integrating metacognitive strategy instruction with course content review [18]. Both studies reported increased student awareness of their own learning processes and improved academic performance, highlighting the potential of sustained course-integrated approaches to support higher-order learning.

### *Our Work*

Our work described in this paper builds on the course-term-duration approaches to course-integrated learning skill interventions described above. Specifically, it is inspired by the work of Graham, Bohn-Gettler, and Raigoza [18]. However, it addresses the specific challenges of a large introductory engineering course, focusing on a different mix of strategies. Specifically, we put an emphasis on anchoring our learning skill intervention to engineering problem solving and conceptual understanding.

Our contributions in this paper are two-fold:

1. **Methods**: Describe the details of our course-integrated learning strategy intervention, targeted towards the specific challenges of a large introductory engineering course.
2. **Results**: Evaluate its effectiveness and effects on students’ learning behaviors and outcomes.

## Methods

### *Context*

The goal of this work was to design and implement a learning skills intervention that promotes transferable learning practices, supporting student success both within the course and beyond it. Building on prior research described earlier, we embedded the intervention directly within the structure of a required engineering course, rather than offering it as a supplemental or optional resource.

**Course**: The intervention was integrated into ECE 35 "Introduction to Analog Design", an introductory electrical circuits course in the Electrical and Computer Engineering Department at UC San Diego. ECE 35 serves as the first engineering course for most students in the major, and as a required core course, functions as a gateway to subsequent coursework in the curriculum. The lecture component of the course was organized as a flipped classroom with peer instruction: students completed pre-lecture video assignments, and in-class time was devoted primarily to conceptual questions and discussion.

In addition to lectures, the course included two weekly 50-minute discussion sections and a three-hour laboratory session every other week. One of the discussion sections each week was repurposed as the learning workshop central to this intervention, while the other discussion section was kept in its traditional format.

**Intervention timeline:** The intervention was implemented across three consecutive academic terms, each consisting of ten instructional weeks followed by a final exam week. The first two iterations focused on refining the structure, pacing, and content of the workshops based on student feedback and observations from the instructional team. Preliminary results on these iterations were reported in earlier work [41]. This paper reports results from the third and most complete implementation, offered in Fall 2025.

**Enrollment**: The course is a large-enrollment course. In Fall 2025, 309 students were enrolled at the start of the term, with 285 students completing the final exam.

### *Course Structure*

The intervention consisted of weekly 50-minute workshops held during one of the course's scheduled discussion slots, which took place on Wednesdays at 5pm. Unfortunately, our university's enrollment system does not clearly inform students of conflicts between a discussion section and other courses. While potential conflicts are flagged to students, these warnings are not always obvious, and some students were unable to attend the workshops as a result. To accommodate this, all workshops were recorded, and all materials were made available for asynchronous access. These materials included a dedicated website containing slides, references, and links to supplementary videos.

Because attendance was not feasible for all students, participation credit could not be offered and no incentive was provided. Attendance was nevertheless strongly encouraged, and the purpose and potential benefits of the workshops were discussed during lecture.

### *Intervention Design*

The content of the workshops was based on research from cognitive psychology and engineering education. Topics included foundational constructs such as growth mindset [19] and self-regulated learning [20, 21], as well as a set of empirically supported learning strategies [22, 23, 24, 25, 26]. Prior to each workshop, students were suggested two to three short videos to familiarize themselves with the learning-skill topic of the week. These videos were selected from freely available YouTube content produced by a range of educational creators.

The workshops discussed the various learning-skill concepts in depth. Rather than only presenting the information, structured group discussion and interactive components were added in which students applied specific techniques to problems drawn directly from the course's technical content. While topics such as time management [27] or getting adequate sleep [28] do not readily lend themselves to in-class practice, other strategies such as elaboration, recall, explaining to others, and concept mapping [22, 25] were well suited to be integrated as guided collaborative exercises.

This approach was chosen for two primary reasons:

1. Embedding learning strategy instruction within the technical context of the course has been shown to support effective transfer and the development of lifelong learning skills [2, 10, 11].
2. Applying the strategies to course-relevant material also provides additional opportunities for students to strengthen their mastery of the technical content itself. These activities differ from traditional discussion formats by emphasizing meaning-making and reflection rather than problem completion alone. For example, instead of solving a problem, students might be asked to generate questions, explain underlying principles, or reflect on sources of difficulty, thereby engaging with the material in qualitatively different ways.

Each workshop focused on a distinct set of learning concepts or strategies. Over the ten-week term, eight workshops were offered. No workshops were held during the final two weeks of the term: one week was omitted due to a holiday break, and the other was devoted to final exam review.

*Workshop Modules*

Each workshop is built on the principles and strategies described above, introducing new concepts or deepening prior ones. The following sections summarize the focus and activities of each of the eight weekly workshops.

**Week 1: Levels of thinking:** This workshop introduced conceptual understanding as the primary goal of learning, framed through Bloom's taxonomy [24, 29]. Students reflected on how these levels related to the course learning outcomes and expectations in prior courses. The session also covered the study cycle [30] and effective time management, linked to the "forgetting curve" (Ebbinghaus curve) [27].

**Week 2: Mindset and Self-Regulated Learning:** A growth mindset is positively correlated to academic success [31], but research shows it cannot be developed simply by explaining its benefits [19]. Instead, students completed the PERTS online module [32], which is designed to promote growth mindset, as a preparatory task. The workshop then reinforced this by exploring neuroplasticity through concrete examples [33]. Finally, it introduced self-regulated learning and metacognition [24, 34], providing a foundation for applying these strategies in later workshops.

**Week 3: Applying Self-Regulated Learning:** Self-regulated learning was explored in greater depth, reviewing both high-level frameworks [20, 21, 26] and case studies [12, 16, 35]. Students then applied these concepts to their preparation for an upcoming exam in the course, culminating in group discussions and exploring practice problems.

**Week 4: Elaboration and Concept Maps:** The focus shifted to concrete strategies for knowledge integration. Elaboration and concept mapping [22, 23, 25] were introduced through interactive, course-specific exercises. These exercises were often structured so that the same course topic was explored across consecutive activities, giving students practice applying different learning strategies.
Figure 1 illustrates this through an example. Students first created a concept map connecting topics, then generated their own elaboration questions inspired by the map. The instructor then provided example elaboration questions, which students answered in a peer-instruction exercise to reinforce the course content.

(a) Concept map question

(b) Answer to the concept map question of part (a) (shown partially), and follow-up elaboration prompt.

(c) Example elaboration prompt as an answer to part (b). Answering this tests their conceptual understanding.

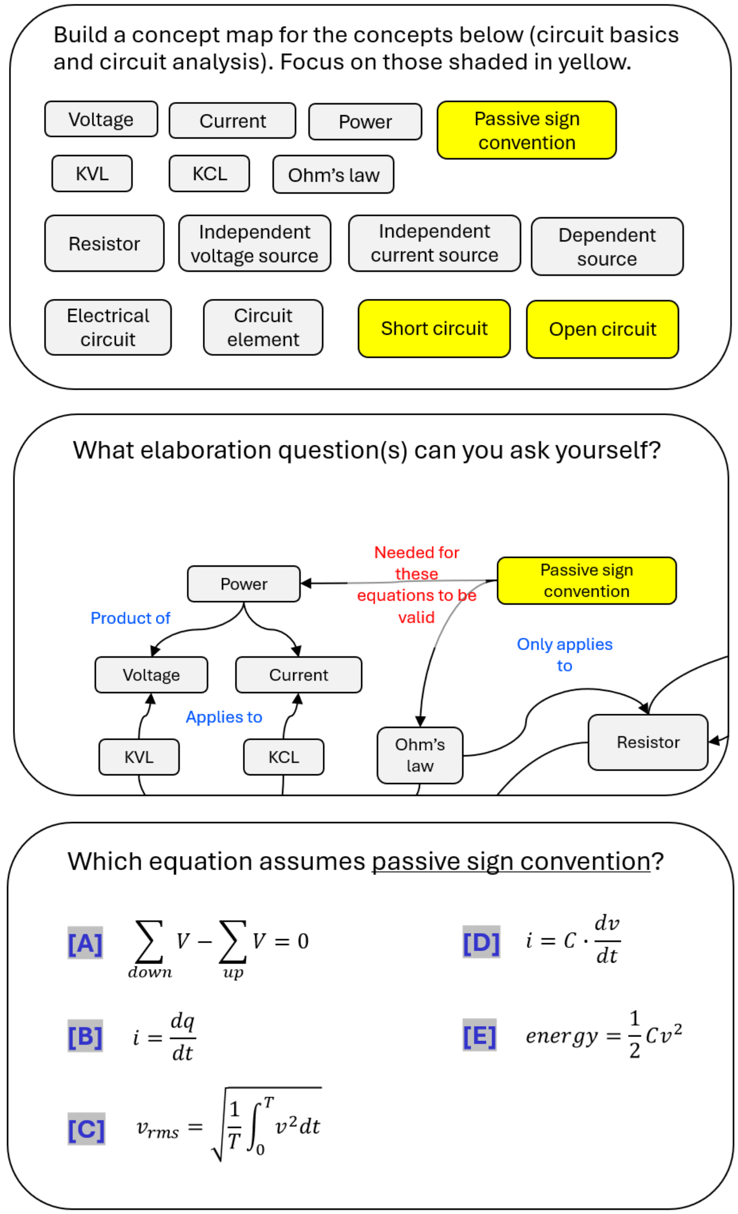


**Figure 1.** Example question progression, focusing on different learning strategies.

**Week 5: Grit & Retrieval Practice, Spaced Practice and Interleaved Practice:** The workshop began by introducing the concept of grit, as popularized by Duckworth [36], emphasizing the importance of effort and persistence. It then introduced retrieval practice, spaced practice, and interleaved practice [22, 25, 37] as learning approaches to reinforce mental frameworks. Exercises included multi-layer questions combining prior and new strategies (e.g., recall → elaboration → peer instruction and content knowledge), similar to Figure 1. These layered exercises, which link different approaches and provide additional practice for strategies from prior weeks, were continued in subsequent weeks; for brevity, we do not repeat them in the following descriptions.

**Week 6: Feynman Technique:** The Feynman technique is a learning strategy based on the idea that mastering a concept requires the ability to explain it simply and clearly to someone else [38]. To practice this approach, each student was assigned one of two challenging questions. They first solved the problem individually and then planned how to explain their solution. Students were then paired with a member of the other group to share their explanations. The session concluded with a discussion comparing different approaches and verifying understanding.

**Week 7: Applying Learning Techniques to a Specific Course Concept:** This workshop shifted focus from introducing strategies to applying them to a specific course topic: complex numbers. Many students enter the course with gaps in this prerequisite knowledge. The session aimed to fill these gaps while reinforcing self-regulated learning, encouraging students to actively plan, monitor, and reflect on their understanding as they engaged with the material.

**Week 8: Behavioral and Environmental Strategies:** The final workshop addressed behavioral and environmental strategies that support effective learning. Topics included study habits such as sleep and breaks (e.g., the Pomodoro technique) [25, 28, 39], as well as factors affecting attention and alertness, including study environment, context switching, and exercise [25, 40]. Collaborative strategies, such as group work and help-seeking, were also discussed [22].

Throughout the workshops, ideas and strategies were reinforced through group discussion, reflection, and application exercises. These activities were often scaffolded to link the practice of learning strategies with the strengthening of course content, as illustrated in Figure 1. This dual focus on strategy and domain knowledge distinguishes these workshops from generic interventions, making the learning experience both practical and immediately relevant, and supporting skill transfer.

## Results

Having described the intervention in detail, we now turn to its evaluation.

### *Data Collection*

As noted earlier, workshop participation was voluntary. To assess student impressions of the workshops and evaluate changes in self-perceived mastery of learning skills, two surveys were administered:

1. **Pre-survey**: Sent during the first week of the term, before the first workshop, this detailed survey required approximately 20 minutes to complete. It asked about current learning approaches, growth mindset, and general study habits. Three attention-check questions were included in the multiple-choice sections. After removing a few (5) responses that failed these checks, 164 surveys were retained.

2. **End-of-term survey**: Sent during the final week of the term, after the last workshop but before the final exam, this survey largely mirrored the pre-survey, with additional questions about workshop participation and the application of strategies during the term. Completion required about 25 minutes. After excluding responses that failed attention checks, 93 surveys were retained.

Responses were anonymous to the instructor, but unique identifiers allowed matching across surveys. A total of 60 students completed both surveys. Response rates are summarized in Table I. Both surveys were sent to all students, regardless of workshop attendance.

**TABLE I.** SURVEY RESPONSE RATES

| | Pre-survey | End-of-term survey | Both pre-survey and end-of-term survey | Total course enrollment |
|---|---|---|---|---|
| Number of valid responses | 164 | 93 | 60 | ~ 300 |

### *Workshop Participation*

During the workshops, students responded to polls and submitted reflections through anonymous forms to encourage engagement without creating stigma. Not all attendees submitted responses, but combining response rates with manual headcounts, weekly workshop attendance was estimated at 30–40 students, except for the first session, which had approximately 85 attendees. Because submissions were anonymous, it was not possible to determine individual attendance across multiple workshops.

Instead, to relate survey responses to workshop participation, we relied on self-reporting in the end-of-term survey. This survey included a three-part question: "Did you participate in our workshops on effective study techniques?" Students indicated how often they (1) "Attended in person," (2) "Watched the recordings," and (3) "Went through the website materials," with choices "All," "Some," or "Never/none." Responses were converted into a single participation score using the point system in Table II. For example, a student answering "all" for in-person attendance, "never" for recordings, and "some" for website materials, received a score of 8 + 0 + 1 = 9. The point system reflects the relative value we assign to each type of engagement, with in-person attendance considered most impactful, watching recordings moderately valuable, and reviewing website materials still useful but less so.

**TABLE II.** PARTICIPATION SCORE CALCULATION TABLE

| | Attended in person | Watched the recordings | Went through the website materials |
|---|---|---|---|
| Score (all / some / never) | 8 / 4 / 0 | 4 / 2 / 0 | 2 / 1 / 0 |

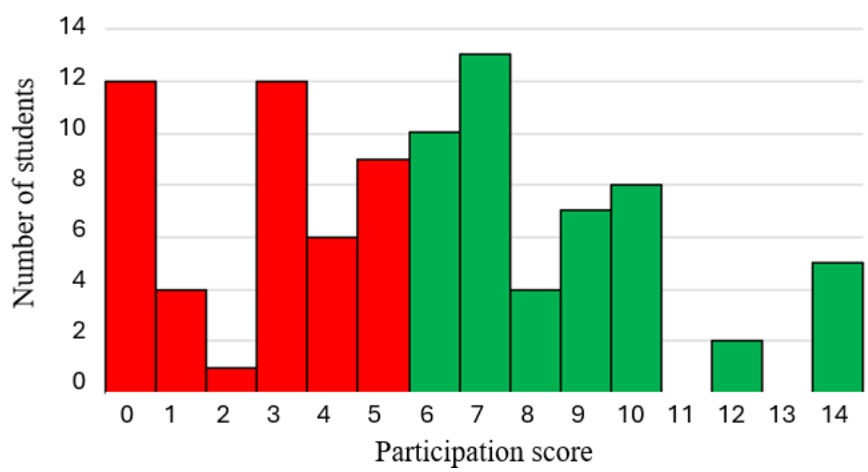


**Figure 2.** Participation score distribution of students who completed the end-of-term survey (n = 93).

Figure 2 shows the distribution of participation scores for all end-of-term survey respondents. For further analysis, students were split into two groups: a high participation group (score ≥ 5) and a low participation group (score < 5), marked in green and red in the figure respectively. The cutoff was chosen so that students who had at least attended some workshops and watched some recordings were considered to have participated. The high participation group contained 49 students, and the low participation group 44. Figure 3 shows the same data restricted to students who completed both the pre- and end-of-term surveys, with a high/low split of 35 versus 25.

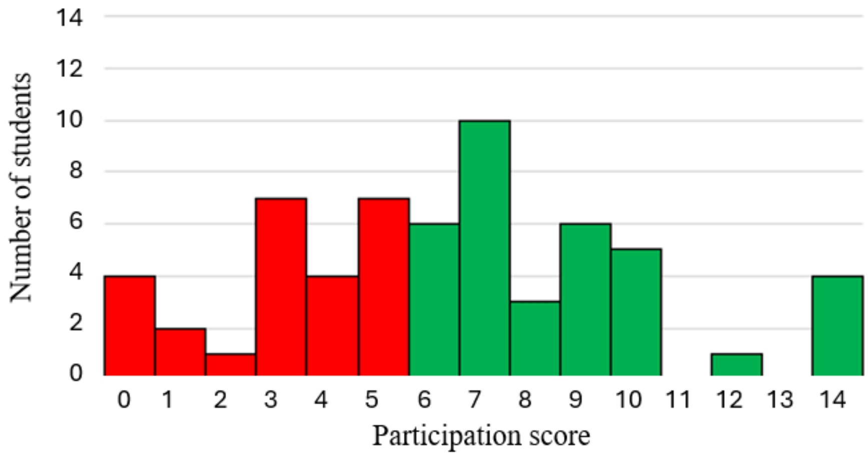

**Figure 3.** Participation score distribution of students who completed both the pre-survey and the end-of-term survey (n = 60).

To investigate the motivation of students to participate in the workshops, the following open-response question was included in the end-of-term survey: "Why did you participate or not participate in the workshops on effective study techniques?" The open-ended responses were coded into thematic categories and analyzed using content analysis. The results are presented in Figure 4. Not all students provided an answer to this question, and some respondents provided more than one answer. We also noted that many students who attended some, but not all workshops, focused on provided a reason for missing some rather than the motivation for partially attending.

As mentioned earlier, one common reason for not attending was scheduling conflicts with other classes, an unfortunate consequence of enrollment system at our institution. Separately, several students reported conflicts with work schedules or other obligations, such as participation in student organizations. These conflicts may have been exacerbated by the evening timing of the discussion section. Due to high demand for large lecture rooms, lectures are given priority over discussion sections, resulting in many discussions being scheduled at less desirable times, such as early mornings or evenings. Some students cited inconvenient timing without specifying an explicit conflict. Other reasons for non-attendance included not perceiving value in the workshops: some students had been exposed to similar study strategies through other programs, felt confident in their current approach, or were not persuaded by the brief motivational examples presented in the first-week lectures.

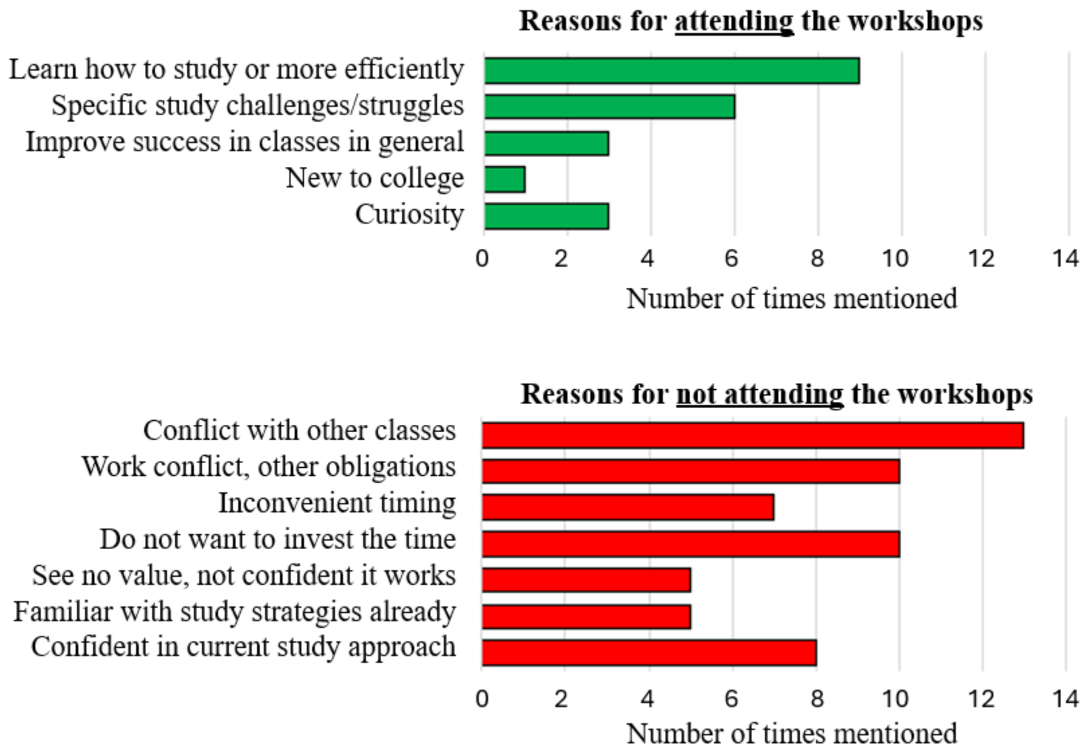


**Figure 4.** Reasons for attending or not attending the workshops, as reported on the end-of-term survey.

### *Effect of Learning Strategy Instruction on Knowledge and Confidence*

To investigate students' self-assessed mastery of learning strategies, two questions were included on both the pre-survey and end-of-term survey: "Rate your knowledge about effective learning strategies" and "Rate your confidence using effective strategies properly based on the course content." Both questions used a 7-point Likert scale. Figures 5 and 6 show the responses, separated by students with high and low participation scores. The mean response is shown to the right of each bar graph, with the top and bottom of the scale set to +1 and -1, and intermediate levels distributed evenly.

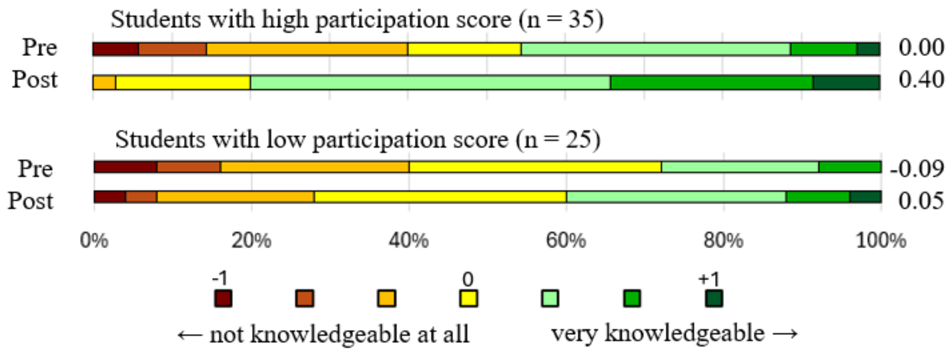


**Figure 5.** Comparison of self-reported knowledge of effective learning strategies: pre-survey versus end-of-term survey, for students who completed both (n = 60).

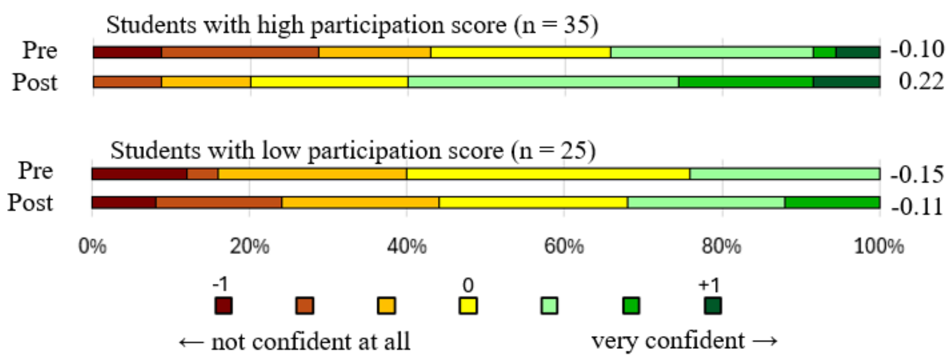


**Figure 6.** Comparison of self-reported confidence in applying effective learning strategies: pre-survey versus end-of-term survey, for students who completed both (n = 60).

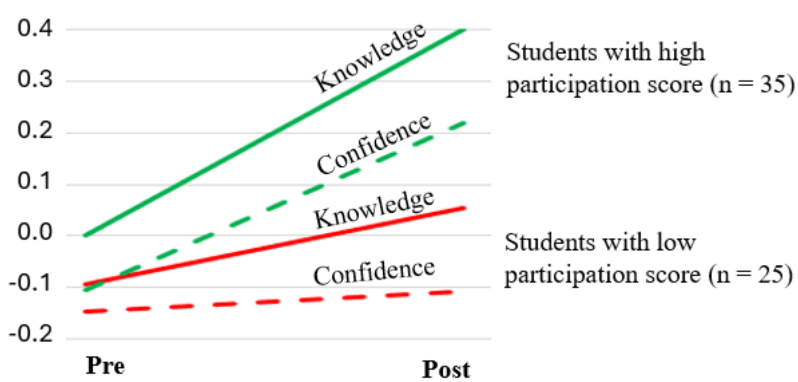


**Figure 7.** Summary of trends of self-reported knowledge of and confidence in applying effective learning strategies: pre-survey versus end-of-term survey, for students who completed both (n = 60).

Figure 7 presents the mean values in a format that highlights changes from pre-survey to end-of-term survey. Both knowledge and confidence increased for both groups, but gains were more pronounced among students with a high participation score, particularly for confidence. A paired t-test confirmed that the high-participation group's gains were statistically significant ($p < 0.01$ for both knowledge and confidence), whereas the differences for the low-participation group were not statistically significant.

***Perceived Usefulness of Various Learning Strategies***

We were also interested in which study strategies students found most beneficial to their actual learning. On the end-of-term survey, students were asked: "From 1 (not useful at all) to 5 (extremely useful), rate the usefulness of each component. Choose NA if you feel this does not apply to you or don't know what it is." The results are shown in Figure 8, with the number on the right of each bar representing the mean response, scaled from -1 (not useful at all) to +1 (extremely useful). This analysis was restricted to students with a high participation score, as responses from other students may not reflect familiarity with the strategies and could introduce noise.

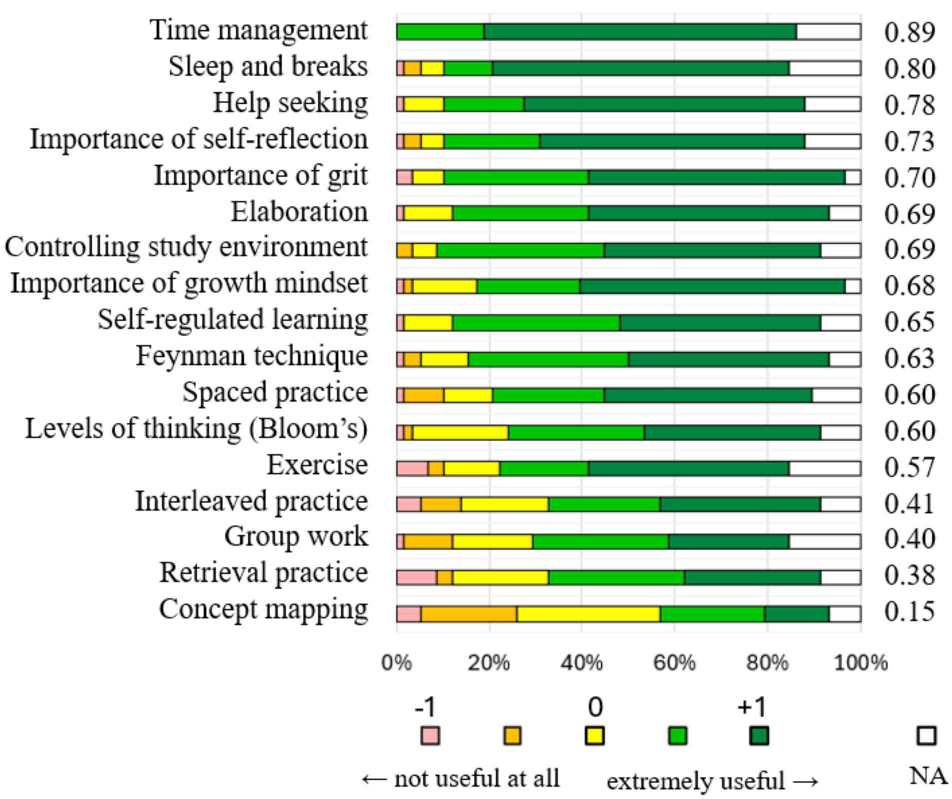


**Figure 8.** Perceived usefulness of learning strategies, for students who completed the end-of-term survey and had a high participation score (n = 49).

All strategies were rated as useful (scores > 0). Time management was seen as most beneficial, followed by other behavioral strategies such as adequate sleep and taking breaks. General attitude strategies, including grit and growth mindset, ranked in the top half. Among the concrete study strategies, self-reflection, self-regulation, elaboration, and explaining to others (Feynman technique) were viewed as most effective. Retrieval practice scored somewhat lower, likely because the course emphasizes problem solving over memorization. Concept mapping was rated lowest, although still useful. This is potentially because students had less practice with it, and the course structure already presents a logical progression between topics, reducing the need to map connections across chapters. Nevertheless, concept mapping remains a promising technique to emphasize in future iterations of this intervention. Help-seeking strategies were also rated highly, which aligns with the course offering abundant opportunities for tutoring and office hours (34 hours per week on average).

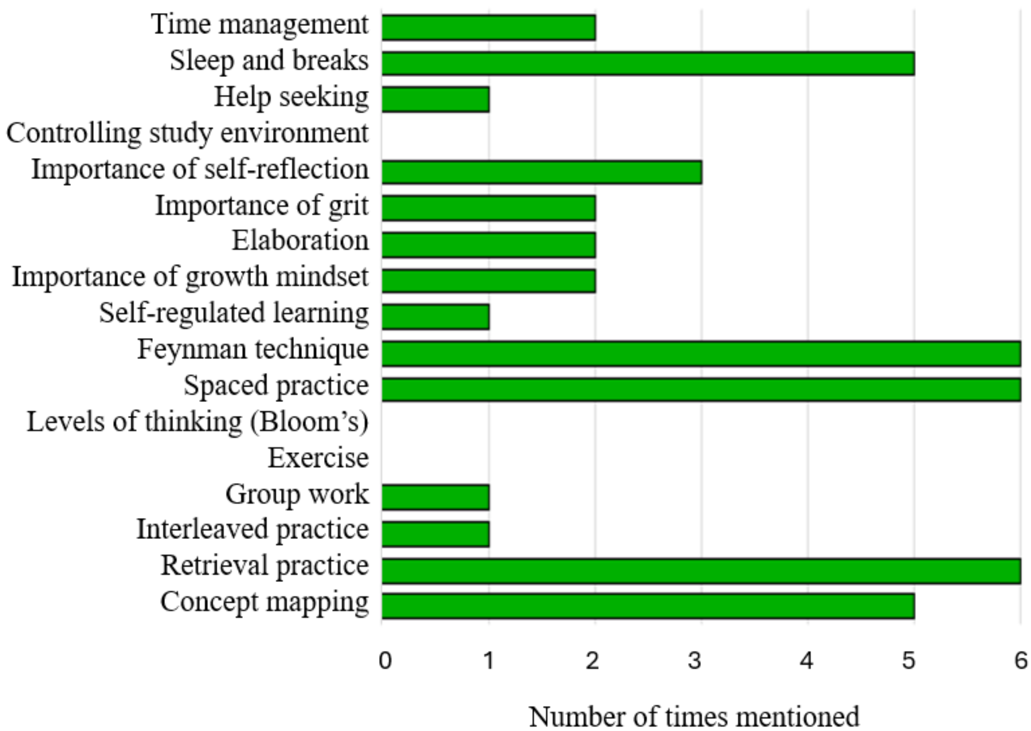


**Figure 9.** Mentions of which study strategies they learned from the workshops and perceived as helpful for the course, from the end-of-term survey (n = 93).

The end-of-term survey also included a related open-response question: "Which study techniques or lessons that you learned from the workshops did you find most helpful for *this course*, if any?" Unlike the multiple-choice ratings presented earlier, this prompt specifically asked students to reflect on strategies learned in the workshops. The prior data captured usefulness more generally, whether they had been using a strategy already prior to these workshops or not.

This open-response question targeted behavioral change. Thirty-three responses were received and coded into categories matching the strategies in Figure 8. The results are shown in Figure 9, listed in the same order as Figure 8 for comparison.

Interestingly, strategies that scored lower in the multiple-choice ratings, such as retrieval practice and concept mapping, received a notable number of mentions in the open responses. This suggests that students who applied these strategies found them valuable. Conversely, some strategies rated highly in Figure 8 received no mentions, perhaps because students were already using them prior to the intervention. The differences between Figures 8 and 9 also highlight the diversity of students' study approaches and the individualized nature of which strategies each student finds most helpful.

***Impact on Performance***

We also explored whether workshop participation correlated with student performance in the course. To this end, we compared scores on the final exam to an earlier assessment. Specifically, the first of three quizzes, administered in week 4 of the 10-week term, was chosen as a baseline, as only the first three workshops had occurred by that point. While not a perfect measure of pre-intervention skill, no earlier data was available, and performance in prerequisite courses could not be used due to a substantial number of incoming transfer students, who had satisfied the prerequisite courses at community college

Table III shows exam performance for the high and low participation groups. A few students were excluded due to missing exams. Both groups scored lower on the final than on quiz 1, which can be attributed to the comprehensive nature of the final and the increasing difficulty of later course content, as this was a trend also observed prior to implementing the intervention.

**TABLE III.** COMPARISON IN EXAM PERFORMANCE

| | Quiz 1 | Final | Difference |
|---|---|---|---|
| Students with a high participation score (n = 33) | 51.6% | 48.5% | -3.1% |
| Students with a low participation score (n = 25) | 61.5% | 55.5% | -6.0% |

Comparing groups, students with higher workshop participation experienced a slightly smaller drop in exam performance, hinting at a positive effect, although this difference was not statistically significant. We also note that the high participation group had lower initial scores, suggesting the workshops may have reached students who had lower academic (or prior) preparation and who may have benefited more. This highlights an advantage of embedding learning strategy workshops within the course, reaching all students and avoiding the potential stigma that may be present for some standalone, remedial interventions [8, 9].

We acknowledge that because participation was voluntary, self-selection bias may influence these results. However, the fact that higher-engagement students tended to be academically less prepared suggests that participation was not limited to already high-achieving students. Nonetheless, caution is warranted, as overall workshop attendance and survey response rates were relatively low. At this point, we do not believe it is appropriate to draw definitive conclusions about the direct impact of the workshops on course performance. However, the positive effects on students' self-perceptions of their mastery and the usefulness of learning strategies, as illustrated earlier, are encouraging, as these factors are generally correlated with improved academic success.

## Conclusions

In this work, we presented a series of weekly workshops focused on effective learning strategies and habits, embedded within a large, required lower-division electrical engineering course. The results indicate that participation in the workshops was associated with increased self-reported knowledge of evidence-based study strategies, greater confidence in applying these techniques, and a strong perception of their usefulness. This suggests that explicitly addressing how students learn, alongside what they learn, can meaningfully shape their engagement with course material.

A core feature of this intervention is its integration into the course structure itself. Unlike standalone learning-to-learn programs, the workshops were directly connected to the technical content students were already studying, allowing learning strategies to be immediately applied in a relevant context. Compared to short-duration embedded interventions, the weekly format provided repeated opportunities for reflection, practice, and refinement across the term. At the same time, the workshops were positioned as a normal part of the course rather than a remedial resource, inviting broad participation and signaling that effective learning strategies are relevant for all students.

Beyond the quantitative results, student feedback points to deeper engagement for a subset of participants. In open-ended survey responses, some students reported independently seeking out additional resources on how the brain works in response to discussions of growth mindset and learning processes. While anecdotal, these responses suggest that the workshops resonated strongly with some students and sparked curiosity extending beyond the immediate course requirements.

While the workshops were designed to be broadly accessible, participation levels indicate room for improvement. Increasing engagement remains an important direction for future work, both to strengthen impact and to reach a larger fraction of the students. One possible approach is to explore different incentive structures, while still being mindful of students' potential scheduling conflicts. Another possible direction is to incorporate key elements of the intervention directly into lectures, which have a broader reach and are far less susceptible to scheduling conflicts. This could allow all students to benefit from exposure to core ideas, while retaining the discussion sections as a venue for deeper engagement, practice, and reflection. As we refine our intervention, it is our intent to make the resulting materials broadly available to the community so that they can be adopted in other courses and institutions.

## Acknowledgements

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