Examining the Role of Identity in Engineering Students' Takeaways from a Self-Regulated Learning Reflection Activity

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Introduction

This empirical full-length paper presents findings on the connection between sense of belonging (SOB) and self-regulated learning (SRL) in engineering education, with an emphasis on minoritized students. Rapid innovation in STEM requires professional engineers to learn new skills and adapt to technological changes as they arise [1]. As such, the rigor of undergraduate engineering programs in the United States demands that students develop efficient and effective learning strategies in order to succeed academically, as well as in their future engineering careers. While strong technical knowledge still remains a key feature of an accredited engineering program, prompting the development of effective learning strategies is critically important for students entering the workforce and seeking post-baccalaureate opportunities. Given the extensive coursework required in most engineering programs, it is thus beneficial to investigate how students' SRL abilities can be developed. However, systemic issues in engineering programs continue to disproportionately affect minoritized students, often leading to a decrease in students' SOB and, as a result, overall achievement [2]. In 2023, for instance, it was reported by the American Society of Engineering Education that a mere 17.2% of engineering degrees were awarded to students of minoritized status [3]. Given previously reported links between students' SRL abilities and SOB, activities that simultaneously foster SRL behaviors and bolster students' SOB appear beneficial [4], [5], [6]. This is especially true in engineering where the SOB disparity between majoritized and minoritized students is particularly pronounced. These identity-based differences in SOB between certain groups of engineering students may produce unique interactions between SOB and SRL improvement. In the study presented, SRL skills were introduced to students while simultaneously attempting to enhance their SOB. This was accomplished via reflection activities featuring peer feedback.

Previous work on reflection activities that feature opportunities for peer feedback has illustrated that these types of activities promote SRL development [7]. Additionally, positive interactions with peers of one's own identity have been shown to support minoritized students' SOB [8]. So, minoritized engineering students could experience enhanced SRL and SOB gains if they provide feedback to and receive feedback from another minoritized peer during reflection activities. In this paper, we observed minoritized students' SRL and SOB gains as a function of which peers they gave and received feedback from during reflection activities (i.e., either a majoritized peer or a fellow minoritized peer). This is a novel attempt at providing minoritized engineering students the support they need to achieve at the levels of their majoritized peers. As such, this current study addresses the following two research questions:

1) To what extent do minoritized students' SRL abilities and SOB improve by completing reflection activities that involve feedback from another minoritized peer?
2) Does a greater SOB improvement correlate with a greater improvement in SRL abilities?

Note on Terminology

In this paper, we frequently describe students as "minoritized", and by doing so, we are referring to the fact that they are not in the majority group of STEM students in the United States. The majority groups in the US are: Asian, Asian Indian, or White non-LGBTQIA+ men. This categorization is made largely based on numerical demographics, but also on the lived experiences students report based on their identity. For example, at the university at which this study was conducted, Latine students actually outnumber White students; however, societal pressures and long-lasting patterns of racism cause Latine students to be seen as minoritized. This is especially true in STEM. We use the term majoritized to emphasize that Asian, Asian Indian, or White non-LGBTQIA+ men students are in the majority, and have been given more power as a result. We seek to analyze students' SOB and SRL behaviors while respecting the unique ways in which they define their identities. In our pursuit of analyzing minoritized and majoritized STEM students as a whole, we report some findings between binary groups of either minoritized or majoritized students without further disaggregation. We strive to present informative correlational data between groups, both broadly and specifically, in a respectful manner while recognizing the many heterogeneities present in our sample.

Additionally, our focus on minoritized students necessitates a discussion of gender because women have historically been minoritized in engineering. Our joint questionnaire allowed students to self-report or voluntarily omit their gender identity, so we will not use biological sex-related terms (i.e., male and female) when referring to students. Instead, we refer to groups of students using their reported gender identity (e.g., a group of students who identify as men) in order to respect students' gender identities.

Literature Review

Self-Regulated Learning

Prior to more recent work on improving students' ability to self-regulate in STEM fields, the field of SRL has been investigated by educational and psychological researchers for the past four decades. Pintrich synthesizes the conceptualizations of various SRL researchers (e.g., [9], [10]) to generally define SRL as a process in which individuals actively and constructively attempt to monitor, regulate, and control their cognition, motivation, and behavior in order to attain the learning goals they have set [11]. Various SRL models have garnered attention, with Zimmerman's remaining the most widely-cited. His theory asserts that learners self-regulate via a cyclic process involving sequential forethought, performance control, and self-reflection phases [9]. Each phase is characterized by a few general processes that are further broken down into specific activities in which the learner engages. For instance, the forethought phase includes task-analysis, a general process containing skills such as goal setting and strategy planning. Zimmerman's 2000 study regarding a social-cognitive take on self-regulated learning best fits the current work given its emphasis on self-reflection at the end of a learning task.

SRL is distinct from other processes students engage in during learning tasks. In fact, SRL models often incorporate various other learning behaviors in their formulations. SRL involves students' cognition, metacognition, and motivation. Each of these processes can be tapped into at various points in Zimmerman's cyclical SRL model. For instance, the performance phase may include utilizing strategies (cognition), monitoring processes and adjusting strategies

(metacognition), and interest incentives (motivation) [12]. These processes appear again in the forethought and self-reflection phases. Each of these individual processes is necessary for students to successfully self-regulate.

Reflection, the phase of SRL guiding this current work, has been conceptualized as one's self-judgments and self-reactions at the conclusion of a learning task [9]. Self-judgment includes comparing one's performance to a set goal or standard (self-evaluation) and attributing outcomes to causes in a self-efficacious manner (e.g. attributing poor performance to poor strategy choice rather than inherent lack of ability). Self-reactions encompass one's self-satisfaction with their performance and involves adapting one's self-regulatory approach to increase performance in subsequent learning tasks. Various works on the reflection phase of SRL have demonstrated a broad array of positive academic outcomes connected to students' reflective abilities, such as academic achievement, self-efficacy, and ability to self-regulate [7], [13], [14]. It has also been shown that combining self-reflection with external feedback enhances the positive outcomes associated with self-reflection [5], [7]. Van den Boom et al. support the previous claim and demonstrate that students receiving reflective feedback score higher on a self-report SRL survey (the Motivated Strategies for Learning Questionnaire, or MSLQ; see [15]) and display a statistically significant increase in SRL abilities [7]. It was also reported that the position of the person giving the feedback influenced these SRL gains, with feedback from an external tutor being more valuable than feedback from a peer. However, this evidence comes from fields (psychology and medicine) with markedly different problem-solving requirements than engineering. Therefore, assessing the efficacy of external feedback on engineering students' SRL abilities requires further examination and is the primary focus of the current study.

SRL in Engineering Education

Despite the fact that the major theoretical underpinnings of SRL were developed in the domains of education and psychology, extensive work exploring the topic has been conducted in engineering classrooms. This previous research has primarily focused on pedagogical interventions that aim to bolster stronger SRL abilities over the course of a singular term or a series of terms. Clark et al. implemented a learning exercise in an engineering fluid mechanics course that asked students to complete reflection activities that touched on planning, monitoring, and evaluation [16]. These three processes comprise the skills involved in effective metacognitive behavior [17]. Measurement by a self-report questionnaire (the Metacognitive Awareness Inventory; see [18]) confirmed that engaging in these reflection activities improved metacognitive abilities to a statistically significant degree. Given the close ties between general SRL and metacognition, it could be speculated that these types of activities will similarly improve students' SRL abilities. Besides the most common quantitative methods of measuring SRL in engineering education—self-report surveys and assessment inventories—some researchers take a qualitative approach with the use of think-aloud protocols (e.g. [19]). In Plumb et al.'s work, this proved useful in differentiating between the metacognitive processes used by entering students versus graduating students when solving problems [19].

SRL research in engineering education is not limited to students' reflective abilities. While many researchers implement SRL-based activities that students actively complete, other research focuses on providing students explicit instruction regarding SRL and how it can be

improved. For instance, implementing discussion about problem-solving features in an engineering course resulted in better use of problem-solving strategies, a key feature of metacognition [20]. In another study, a custom learning module was developed in a thermodynamics course that prompted students to stimulate certain cognitive operations (organization, elaboration, and monitoring) which are necessary to effectively self-regulate [21]. The results demonstrated that the group who used this custom module had better results compared to the group that did not use the module. However, the existing research on SRL interventions in engineering education overlooks students' identities and how they may affect desired outcomes. Often, students are aggregated into high- or low-achievement categories which, while nevertheless important, fails to examine potential trends based on student identity.

Students' Sense of Belonging and SRL

The reported benefits of reflection activities with feedback suggests that these activities may simultaneously increase students' SOB in addition to their SRL abilities. SOB has been linked to numerous positive student outcomes, such as academic achievement, grit, motivation, and engagement [22]. A significant amount of research has examined features of students and the contextual factors of the university environment that affect one's SOB [8], [22], [23], [24], [25]. This is especially pertinent in engineering, a field that historically minoritizes many groups of students. In order to foster a greater SOB in minoritized groups, the factors that cause this improvement must be identified. Various papers in the belonging literature have identified positive peer and faculty interactions, inclusive and diverse peer and faculty demographics, and the existence of identity-based extracurricular organizations as key ways in which minoritized students' SOB can be improved [26], [27], [28], [29]. This is supported by both qualitative and quantitative works that have conducted large-scale numerical modeling of belonging predictors, as well as in-depth phenomenological investigation of which SOB factors are most salient to minoritized engineering students.

Previous research has demonstrated that these belonging factors also positively influence students' SRL abilities. Slaten et al. utilized structural equation modeling and quantitative surveys to indicate that a strong correlation exists between SOB and SRL in youths [4]. This result suggests a similar relationship among college engineering students, yet further work is needed due to the differences in academic environment and personal factors between youths and university students. In their 2021 paper, Won et al. used quantitative numerical modeling in order to investigate the relationship between SOB, SRL, and academic help-seeking [6]. Given the positive effects of SOB on various learning outcomes, including metacognition and self-efficacy, Won et al. demonstrated that SOB positively contributes to students' SRL abilities via an increase in academic help-seeking behavior. Tian et al. further confirmed the positive relationship between SOB and SRL in medical school students [5].

At the very least, a correlative link between SOB and SRL has been established, and a specific instance exhibiting this relationship is in reflection-based activities involving peer feedback. However, the extent to which certain groups of engineering students benefit from these SRL-focused activities has not yet been studied. SRL strategies undoubtedly contribute to student achievement and it is in educators' best interest to implement pedagogical strategies that increase students' SRL abilities. In order for this effort to be successful, it must first be

determined if all students benefit from these activities to a similar extent, regardless of majority or minority status in the engineering classroom.

Methods

This research was conducted with students in an introductory 10-week programming course in an engineering program at a large southwestern R1 university. In total, 249 students were enrolled in the course, with most being first-year students in their first quarter at this university. As will be described below, the finalized sample of 94 students was selected from the total 249 using a variety of selection criteria. Although this course is offered through the university's mechanical and aerospace engineering department, students from other engineering or STEM majors were also enrolled in the course.

Students' SRL abilities were measured using the MSLQ and their SOB was measured using the Psychological Sense of School Membership survey (PSSM). The MSLQ taps students' learning strategies, habits, and behaviors, and the PSSM investigates the extent to which students feel like a member of their campus environment. All subscales of the MSLQ were included in the joint MSLQ-PSSM survey due to the exploratory nature of this work—it was not known *a priori* which subscales would be most meaningful. Both scales are validated measures that have been extensively used to quantify undergraduate STEM students' SRL abilities and SOB [30], [31]. In the first week of the ten-week term, students were administered the MSLQ-PSSM survey as a pretest. Here, students self-reported their gender identity, ethnicity, and time spent in their specific engineering program (e.g., less than 1 year). Ethnicity was collected via a text-entry question that was then coded for categorization. This approach was selected to avoid "othering" students whose ethnic identity is historically marginalized in engineering because traditional demographic surveys often fail to fully capture how students identify. The MSLQ-PSSM survey was readministered in the final tenth week of the term as a posttest.

The interventions involved students completing two reflection activities and observing a mini-lecture on SRL skills. In the fourth, seventh, and tenth weeks of the course, students completed reflection activities designed to capture components of Zimmerman's cyclical SRL model [9]. The reflection activity handouts are presented in the Appendix. The third reflection was a makeup activity identical to the second reflection, so students were excluded from the data if they only completed the second and third reflections. The timing of reflections was intentional so as to coincide with exam dates. Students had previously been placed into small groups for an unrelated group project. These groups were intentionally assigned by the instructional team (i.e. the authors) and were designed to have at least two minoritized students per group when possible. After students responded to the reflection prompts presented in a given reflection activity, they exchanged responses with one of their groupmates. Each student then responded to their groupmate's reflection by providing feedback to their groupmate regarding study skills and habits, motivational skills, insightful epistemological beliefs, or anything else they deemed meaningful. Additionally, in the third week of the term students were given a mini-lecture intended to make them aware of SRL and how to use it to improve their learning skills. The mini-lecture was delivered by the first author and featured extrinsic motivators regarding SRL, a description of Zimmerman's SRL model, and specific instances of how planning, monitoring, and reflection were useful for this particular course.

A convenience sample was used because the authors of this work comprised the instructional team for the class from which data was collected (the first author was the sole teaching assistant, and the second author was the professor). The data collected in this study includes students' ethnicity, gender, time spent in the program, and quantitative data from the MSLQ-PSSM survey. Students' demographic data is summarized in Table A1.1 (in the Appendix). The survey data includes six key variables: each students' average pretest score, posttest score, and posttest-prettest score difference for each survey. It should be noted that the MSLQ contains 7-point Likert scales, whereas the PSSM contains 5-point Likert scales. Valuable qualitative data was also collected via the reflection activities but will not be analyzed in this study. This qualitative data is certainly valuable, but only the quantitative data was analyzed in this study in order to identify larger-scale trends among the data.

A student's survey scores were included in the data if the following criteria were met: the student completed the first and second or the first and third reflection activities (the second and third activities included the same prompts); they provided feedback to and received feedback from the same peer for each activity they completed; they completed both the pretest and posttest; they self-reported their gender and ethnic identity in the pretest; the peer they worked with was also included in the data.

Statistical Analyses

The large sample size ($n = 94$) warranted parametric statistical tests to analyze differences between various groups of students and their MSLQ and PSSM scores. To answer RQ1, students were categorized based on their minoritized status and on the minoritized status of the student they were paired with (the term "paired" henceforth indicates that a minoritized student provided feedback to and received feedback from a minoritized peer). 35 students in the sample were minoritized, and 26 of these students were paired. Independent two-sample two-tailed *t*-tests were conducted to determine if paired minoritized students experienced enhanced development compared to unpaired minoritized students. The *t*-tests were two-tailed to avoid *p*-hacking since directional differences were not known *a priori*. Addressing RQ2 involved conducting pairwise correlations between students' MSLQ and PSSM scores.

Results and Discussion

Overall, the data did not demonstrate any significant differences in SRL ability or SOB between the pretest and posttest. This was true for all students, even when comparing only between paired and unpaired minoritized students. Interestingly, some subscales of the MSLQ did show significant differences when observing the entire sample, although the differences were mostly negative, indicating a decrease. Finally, the correlation between SRL and SOB was positive and statistically significant when observing larger subgroups of the sample.

For the entire sample, descriptive statistics of students' average PSSM and MSLQ pretest scores, posttest scores, and posttest-pretest difference can be found in Table 1. The average score change between the pretest and the posttest for the PSSM and the MSLQ was small and not statistically significant, $t(93) = -.06$, $p = .95$ and $t(92) = -1.69$, $p = .09$, respectively. Also, course

grades for the sample were quite high ($M = 92.48$, $SD = 4.64$) and similar to course grades for every student in the course ($n = 248$, $M = 91.55$, $SD = 5.48$). A z-test demonstrated that the sample and overall course grades were not significantly different, $z = 1.56$, $p = .12$.

Table 1. MSLQ and PSSM Pretest and Posttest Descriptive Statistics, Entire Sample

	MSLQ		**PSSM**	
Metric	***M***	***SD***	***M***	***SD***
Pretest Score	5.06	.57	3.80	.46
Posttest Score	4.97	.75	3.80	.53
Difference	-.10	.57	.00	.38

RQ1: SRL and SOB Changes Between Paired and Unpaired Minoritized Students

In regards to RQ1, independent two-sample t-tests did not indicate that the change in minoritized students' PSSM or MSLQ scores was statistically significant as a function of their paired status. The results of these t-tests are summarized in Table 2. The change in minoritized students' PSSM and MSLQ scores was marginal (on the order of a tenth of a point), regardless of their paired status.

Table 2. *t*-Test Results for PSSM and MSLQ Score Differences for Paired and Unpaired Minoritized Students

	Paired (*n* = 26)		**Unpaired (*n* = 19)**				
Metric	***M***	***SD***	***M***	***SD***	***df***	***t***	***p***
PSSM Difference	.06	.32	-.01	.39	43	-.70	.49
MSLQ Difference	-.15	.51	-.15	.66	43	.02	.98

Since the t-test between paired and unpaired students was somewhat underpowered for assessing such a small difference, the entire sample (including majoritized students) was also considered. The difference between MSLQ and PSSM pretest and posttest scores for the entire sample (Table 1) were also insignificant, $t(92) = -.80$, $p = .42$ and $t(91) = .93$, $p = .35$ respectively.

To look deeper into specific aspects of students' SRL abilities despite the lack of significance, t-tests were conducted for each of the fifteen subscales of the MSLQ. Looking at the entire sample, five subscales changed to a statistically significant degree, the results of which are in Table 3. When looking at the subscale differences only between paired and unpaired minoritized students, no results were statistically significant for any subscale. The five MSLQ subscales reported in Table 3 are the only statistically significant differences detected.

Table 3. Statistically Significant Changes in MSLQ Subscale Scores, Entire Sample

MSLQ Subscale (Posttest - Pretest score)	***M***	***SD***	***df***	***t***	***p***
Intrinsic Goal Orientation	-.26	.94	92	-2.69	.01
Task Value	-.41	1.05	92	-3.76	<.001
Rehearsal	.25	1.11	92	2.18	.03
Time and Study Environment	-.18	.68	92	-2.57	.01
Effort Regulation	-.42	.88	92	-4.58	<.001

Somewhat unexpectedly, four of these five subscales decreased, and only Rehearsal increased. One explanation is that students felt unchallenged in the co and diverted their focus to other more challenging courses they were taking that term. Another possibility is that students realized that they needed to put in less effort to attain the grades they desired in this course. This explanation also accounts for the increase in Rehearsal. Students were successfully meeting their learning goals—one of which being the ability to recall important course material—more easily than expected, causing their goal setting, task value, time spent on the course, and regulation of their effort to decrease. Throughout the quarter, students were also required to create a "support sheet": a supportive document used to help them during exams. This assignment and its benefit during exams may have contributed as to why Rehearsal scores saw an increase.

The statistical analysis did not indicate that the change in students' SRL abilities during the term varied based on their minoritized or paired status. As such, it cannot yet be concluded that minoritized students receive greater SRL ability improvements by engaging in reflection activities with a fellow minoritized student. However, as mentioned earlier, the average grade for all students in the course was quite high—above 90%—and even higher for students in the sample (though not to a statstically significant extent). So, perhaps the course was simply not challenging enough for students to meaningfully reflect on how the course was pushing them to engage with their personal SRL abilities. Of course, student achievement is highly desired and not seen as a negative outcome here. Instead, this setting may have simply been unable to tease out real differences in students' SRL abilities and how these abilities change over the course of a term. A more demanding course may prompt deeper introspection among students as they reflect on their learning skills, therefore enhancing the effectiveness of the reflection activities, possibly more so for minoritized students paired with another minoritized student. Despite the lack of sufficient evidence to claim that paired status significantly impacts students' SRL improvement, a more appropriate setting may be able to accomplish this.

Students' SOB also seems unaffected by their paired status as evidenced by the results of the PSSM. This is likely explained by how almost all students in the sample were first-year students and were new to the university at the time when this study was conducted. Greater social pressures beyond the scope of this class may have diminished any significant SOB gains that minoritized students would have received based on their paired status. Similar to how this course was perhaps not the best suited for assessing SRL ability among minoritized students, it could be argued that piloting this study in a later term may allow changes in SOB to become more readily apparent as students become more acclimated to life in university. Another point is

1that working with another minoritized student may be a necessary but insufficient condition to foster belonging. Perhaps working with peers more closely related to one's actual identity (not just matching their minoritized status) would prove more beneficial.

RQ2: Correlation Between SOB and SRL

To address RQ2, pairwise correlations were conducted between standardized PSSM and MSLQ difference scores across various subgroups of students in the sample. The results of the correlations are presented in Table 4 and a scatterplot of students' standardized PSSM and MSLQ score changes (for the entire sample) is presented in Figure A1.1 (in the Appendix). One student out of 94 completed the full MSLQ posttest but not the PSSM posttest, so their data was not used in the correlation—hence an *n* of 93 in the first row of Table 4.

Table 4. Pairwise Correlations between PSSM and MSLQ Differences

Pairwise Correlation Variables	***n***	**Pearson's *r***
Standardized PSSM vs. MSLQ Difference (Entire Sample)	93	.49*
Standardized PSSM vs. MSLQ Difference (Only Minoritized)	45	.38*
Standardized PSSM vs. MSLQ Difference (Only Minoritized and Paired)	26	.37
Standardized PSSM vs. MSLQ Difference (Only Minoritized and Unpaired)	19	.39

* $p < .05$

All pairwise correlations displayed a positive correlation between students' MSLQ and PSSM score changes, with the correlation coefficient *r* being statistically significant when the entire sample and the minoritized portion of the sample were used in the correlation. These results support the previous claim that students' SRL abilities and SOB are positively correlated. While this claim is not new, these results further cement previous research that links students' SRL and SOB [4], [5], [6]. Even among first-year students who may be experiencing social upheaval as new university students, the correlation between SRL and SOB persists. The lack of statistical significance for the "Minoritized and Paired" and "Minoritized and Unpaired" subgroups may be due to low sample sizes, causing these two tests to be underpowered.

Limitations and Future Research

Significant differences in SRL or SOB gains were not uncovered between paired and unpaired minoritized students. The foremost limitations focus on the setting in which this research was conducted. As evidenced by the high course grades among the sample, this course may not have sufficiently challenged students to improve their SRL abilities. A more challenging course may require students to critique their learning strategies on a deeper level, producing more meaningful reflection during reflection activities. Alternatively, this course was thoroughly planned and well-structured for students, reducing their need to self-regulate at a high level. Courses taught by more hands-off instructors may produce different results. Second, the benefits of pairing minoritized students with other minoritized students during reflection activities is

likely outweighed by other overarching social phenomena occurring in first-year students' lives. Adjusting to living at university and finding belonging among an entirely new group of peers is a powerful change in students' lives, and simply working on two activities with someone of similar identity is likely not enough to significantly sway one's SOB amidst this change. Lastly, a larger sample of minoritized students could increase power in statistical analyses, but it must also be considered how a particular sample maintains parity with actual engineering demographics.

Nevertheless, examining how students' identities and individual SOB affect their SRL gains is crucial to ensuring that SRL-focused initiatives are equitable. The confounding effects of course difficulty and external social changes could be mitigated through a multi-term longitudinal study in which students complete reflection activities in a sequence of courses (or in multiple different courses each term). Further research could also implement a mixed-methods approach to investigate students' experiences with these reflection activities by thematically analyzing the textual reflection data. This could uncover better ways to structure the reflection activities to foster greater SOB and SRL improvement. Additionally, quantitative surveys like the PSSM survey and MSLQ may inadvertently miss some aspects of student experience. Other quantitative methods, such as learning analytics, may prove more effective in future works.

Conclusion and Implications

This quantitative study set out to investigate the role of students' identities in their takeaways from SRL-based reflection activities featuring peer feedback. Given that previous research has asserted a tie between students' SOB and their SRL abilities, it was posited that minoritized students receiving feedback from and providing feedback to another minoritized peer may enhance their SRL gains through an increase in SOB. Statistical analyses did not reveal significant differences between paired and unpaired minoritized students' SRL and SOB between pretest and posttest, possibly due to the setting in which this work was conducted. Future research is needed to determine if working with other minoritized peers and experiencing enhanced SRL and SOB gains truly share a relationship, whether it be correlational or causal.

Meaningful implications for engineering education practice and research arise out of this work. First, SOB is a foundational psychological need for all students that contextualizes every aspect of students' education; considering its place in SRL activities is highly important in the pursuit of greater equity in engineering. Even though it is a difficult construct to track, creating opportunities for students to connect with each other or with faculty is a worthwhile endeavor. Second, belonging research in engineering must continue to examine the granularity at which belonging data is collected. In this work, a pre-post design was insufficient for tracking students' SOB throughout the term. Future work must investigate the appropriate instruments and temporal aspects needed to effectively track and predict belonging. Finally, a greater emphasis must be placed on reflection in engineering classrooms. In this study, limitations may have stemmed from students simply not knowing how to meaningfully reflect. Not only will this produce richer data for future analyses, but providing students with the tools to effectively reflect on their learning has the potential to impart meaningful learning strategies to first-year students.

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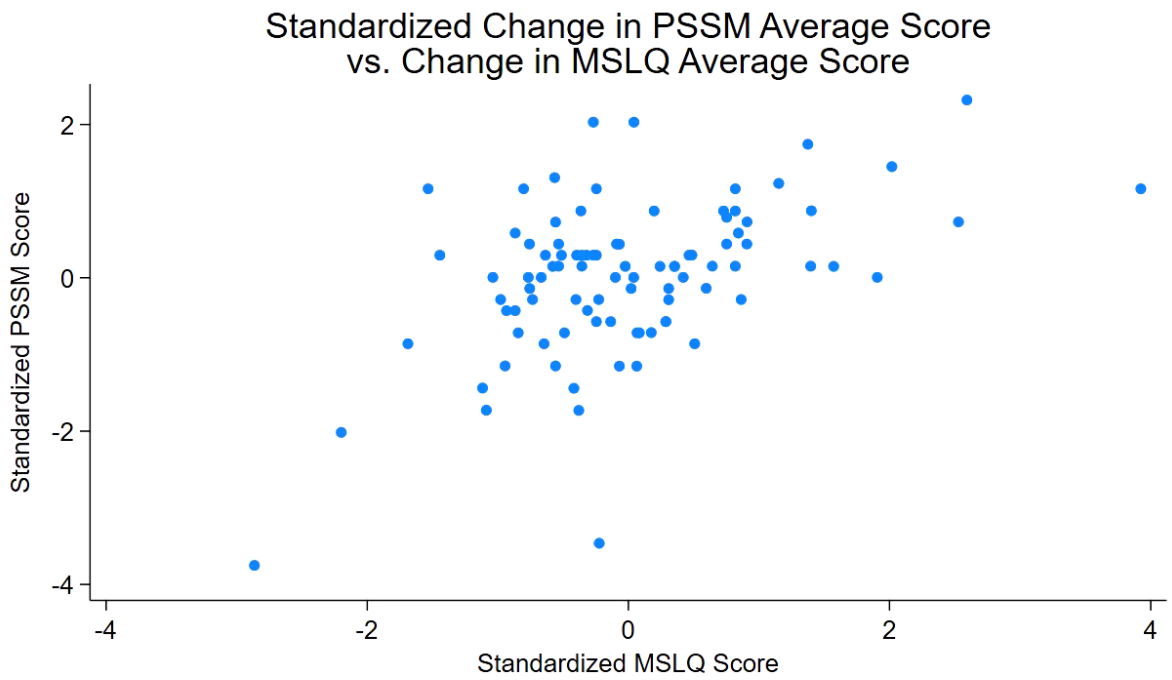
Appendix 1

Table 1. Sample Ethnicity and Gender Demographics

	Count	Relative Frequency (%)
Ethnicity		
Asian	54	57.45
Asian Indian	10	10.64
Latine	11	11.70
Latine, Middle Eastern	1	1.06
Latine, Pacific Islander	1	1.06
Middle Eastern, North African	1	1.06
North African	1	1.06
Pacific Islander	2	2.13
White	13	13.83
Gender		
Man	61	64.89
Woman	31	32.98
Prefer not to answer	2	2.13

Figure A1.1 Scatterplot of PSSM and MSLQ Score Differences



Appendix 2

Learning Reflection Prompts

Learning Reflection 1
Your name (the one submitting):_____
Feedback-giver's name:_____
Please answer the following reflection questions. The more thought you put into considering these reflections, the more you will get out of the activity! Type your answers in black font. Once you have completed your reflection, share it with your partner so that they can provide insight and feedback in blue font. (more details about this under the Learning Reflection assignment on Canvas). Remember, there are no right or wrong answers!

1) Before starting a learning task, do you plan your learning strategy/method? If so, what do you plan, and how do you plan it? If you do not plan ahead, what does your preparation process look like?

2) What are your goals for this course? Which learning strategies do you find are most effective in achieving your learning goals? When and why do you use each strategy?

3) What motivates you to achieve your learning goals? How confident are you in achieving your current learning goals?

4) What do you expect to gain from achieving the goals you have set for yourself in this course?

5) During a learning task, do you monitor your learning (i.e. do you keep track of and evaluate your progress toward your goals)? If so, how?

Learning Reflection 2 and Learning Reflection 3

1) Respond to the learning reflection questions in black font. There is no length requirement, but it is expected you will thoroughly think through and answer each part of each question (likely at least a few sentences per reflection question).

Your Reflective Essay must address the following:

1. Your personal learning goals in [masked course name] and how they changed throughout the quarter
2. What learning strategies or resources were most helpful to you in achieving your goals (be specific! e.g. attending office hours, studying with small group, etc.)
3. Your current beliefs about achieving your goals
4. What learning strategies or resources did you learn in this course that you can use to help you achieve your goals beyond this class (be specific!).
5. What this reflection essay means to you as an engineering student
   Your essay must follow the format specified below:

    - *Between 300 and 400 words, using complete sentences*
    - *One paragraph for each of the five sections above*

2) Within your Final Project Team, exchange your reflection with a partner. If in a group of 3, do a 3-way exchange so that no one has their own reflection.

3) As the feedback-giver, use blue font to add feedback on your peer's reflection responses. Feel free to include helpful ideas/strategies, useful ways to think about course content, effective study skills, motivational skills, etc.