

Enhancing Self-Regulation and Motivation for Hispanic or Latina/o/e Transfer Students in Engineering Courses

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Abstract: STEM college courses are difficult for new students as they transition from high school, which may be heightened for minoritized groups. The goal of this study is to investigate how Engineering course activities impact minoritized students' self-reported motivation and use of self-regulated learning strategies. A Kruskal-Wallis test examined differences between ($n=224$): (1) Hispanic or Latina/o/e transfer students, (2) Hispanic or Latina/o/e non-transfer students, (3) non-Hispanic or Latina/o/e transfer students, and (4) non-Hispanic or Latina/o/e non-transfer students. Results revealed Hispanic or Latina/o/e transfer students had significantly higher mastery-approach scores than other students. Implications are to encourage teachers to implement activities that foster student self-regulated learning and motivation to ensure *all* students are successful in their STEM courses and future careers.

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Objectives and Theoretical Framework

Learning in STEM college courses can be difficult as students are presented with challenging content as well as the new expectations they have as they transition from high school (Conley, 2018). These challenges may be heightened for minoritized groups, such as transfer students who identify as Hispanic or Latina/o/e. For students who identify as Hispanic or Latina/o/e, the curricula do not typically contain inclusive content and there is a small faculty population who identify as Hispanic or Latina/o/e in STEM (Rios Aguilar & Kiyama, 2012). This can make it challenging for students to identify with the content and with the faculty who deliver that content. For transfer students (i.e., students who transferred from a different institution), they enter a large university, which is a different learning setting from what they are used to. Classes are now much larger than before, and they do not receive the same level of one-on-one support (McGowan & Gawley, 2006). This sometimes makes it challenging to manage schoolwork across many courses, in addition to other life responsibilities. The end goal for all college students is to gain a valuable education to helping them achieve in all future career paths. However, given the obstacles faced by transfer students *and* Hispanic or Latina/o/e students alone, students who belong to both groups—i.e., Hispanic or Latina/o/e transfer students—have additional barriers to overcome.

To ensure success for *all students*, we need to foster their self-regulated learning (SRL), which views them as active participants in their learning context. According to the Information Processing Theory of SRL (Winne & Hadwin, 1998), learning is a cyclical process in which students implement strategies related to planning and goal setting, metacognitive monitoring and control, and self-reflection and making adaptations to the existing goals, plans, and learning strategies. There are many SRL strategies a learner can implement (see Greene & Azevedo, 2009), such as: making inferences (relating content to one's own life) or judgment of learning

(knowing how much one understands and when to ask for help). If we foster these processes, it has the potential to improve the learning experience in STEM-based and other college courses.

Research demonstrates fostering SRL processes can enhance student motivation, impacting their course learning outcomes (Schunk & Greene, 2018). There are many ways to do so in a STEM course while also accounting for student identities. For example, assigning mini-projects involves students using a hands-on approach to engage in problem solving a real-world example from a topic studied in class (e.g., Momentum), allowing students to connect course topics to their life experiences. Blended learning also involves solving real-world problems via problem-based homework that students complete after watching a video lecture. Like with mini-projects, students can choose problems that relate to their own lives. Implementing multiple test attempts in a course allows students more chances to take an exam. After the first attempt, students can self-reflect on what they did or did not think they understood and adapt their study strategies to cover the additional material. In these course activities, there is the potential for students to actively engage in learning by applying material to their own lives or making sure they understand the content and asking for additional help, if needed. Instructors of these courses have reported students have positively reacted to these course activities.

The goal of this study was to investigate how implementing mini-projects, blended learning, or multiple test attempts into engineering courses impacts students' self-reported: motivation (self-efficacy and achievement goals), and use of self-regulated learning strategies.

Methods and Data Sources

This study is a part of an NSF grant [number blind for review] that aims to improve undergraduate engineering education to be equitable and inclusive to all students, with a specific focus on transfer students who identify as Hispanic or Latina/o/e at a large southeastern university in the United States. In the first year of the project, we focused on a total of 270 undergraduate students enrolled in three engineering courses: Dynamics, Statics, and Thermodynamics. These courses implemented differentiated coursework such as mini-projects, blended learning with problem-based homework, or multiple test attempt activities (see above) due to the challenging nature of the classes.

During the Spring 2023 semester, students were asked to complete online surveys approved by the university's IRB and administered via Qualtrics at the beginning and the end of the semester. Here, we report on responses from the end of the semester after the activities were implemented¹. All students completed questions from the metacognitive self-regulation scale of the Motivated Strategies for Learning Questionnaire [MSLQ] ($\alpha=.79$; Pintrich et al., 1991), the Achievement Goals Questionnaire-Revised [AGQ-R] ($\alpha=.84$ [mastery-approach]; $\alpha=.88$ [mastery-avoidance]; $\alpha=.92$ [performance-approach]; $\alpha=.94$ [performance-avoidance]; Elliot & Murayama, 2008), and the General Self-Efficacy Scale [GSE] ($.76 \leq \alpha \leq .90$; Chen et al., 2001). Students were also asked to report whether they identified as Hispanic or Latina/o/e and if they were a transfer student. For this study, out of the 270 students enrolled in the courses, there were complete data sets for 224 students: 72 students identified as Hispanic or Latina/o/e and 152 students identified as non-Hispanic or Latina/o/e. There were also 85 transfer students and 139 non-transfer students. The students were then separated into four groups:

¹ We were unable to examine changes from pre to post because surveys were anonymous.

- (1) Hispanic or Latina/o/e transfer students[HL-T] (n=29)
- (2) Hispanic or Latina/o/e non-transfer students[HL-nT] (n=43)
- (3) non-Hispanic or Latina/o/e transfer students[nHL-T] (n=56)
- (4) non-Hispanic or Latina/o/e non-transfer students[nHL-nT] (n=96)

We analyzed questionnaire responses based on the specific measures investigating metacognitive self-regulation of the MSLQ, achievement goal orientation, and general self-efficacy.

Results

RQ1: Are there significant associations between reported SRL, achievement goals, and general self-efficacy?

According to a Pearson's correlation, all questionnaire responses are positively correlated with each other with medium to large effects (all $p < .05$, see Table 1).

We also ran correlations for each group (adjusted $\alpha = .0125 [.05/4]$). Most correlations were still significant at the .001 or .01 level for at least one group, however some correlations were no longer significant with significance only at the .05 level or were $> .05$ (see Table 2). Specifically, MSLQ score is no longer correlated with mastery-avoidance, performance-approach, or performance-avoidance scores for any student group; and general self-efficacy is no longer correlated with performance-avoidance scores for any student group.

Comparing the significant correlation coefficients across groups, the HL-T and nHL-T groups had the strongest correlation coefficients for 4 and 5 correlations, respectively, for each out the 14 significant correlations (i.e., 9 correlations total). The nHL-nT group had the strongest coefficients for 2 correlations. This includes:

- (1) The HL-T group had the strongest correlation coefficients between: GSE and mastery-approach, mastery-avoidance, and performance-approach, and mastery-avoidance and performance-avoidance.
- (2) The nHL-T group had the highest correlation coefficients for MSLQ and mastery-approach and mastery-avoidance, mastery-approach and mastery-avoidance, and performance-approach and mastery-approach and mastery-avoidance.
- (3) The nHL-nT group had the highest correlation coefficients for GSE and performance-avoidance, and mastery-approach and performance-avoidance.
- (4) The HL-nT group had the highest coefficient for MSLQ and performance-approach; however, it was no longer significant at the .0125 level (there was still a significant correlation for the nHL-nT group despite a lower coefficient, likely due to sample size).

In addition, there were 2 coefficients that were the highest (and the same) for 2 groups:

- (1) The HL-nT and nHL-T groups had the highest correlation between MSLQ and GSE.
- (2) The HL-T and nHL-T groups had the highest correlation between performance-approach and performance-avoidance scores.

Overall, these results demonstrate a clear positive association between self-reported SRL and motivation. However, it is important to examine these correlations between student groups because correlations can be stronger or weaker depending on student group.

RQ2: Are there significant differences in reported SRL, achievement goals, and general self-efficacy between Hispanic or Latina/o/e transfer groups?

A Kruskal-Wallis test² with 1 IV (4 levels) and 6 DVs (questionnaire responses) revealed significant differences between groups for the AGQ-R – mastery-approach scale; $H(3) = 8.933, p < .05$ (see Table 3).

Specifically, the score for mastery-approach was significantly higher for transfer students who identify as Hispanic or Latina/o/e (HL-T; $M=13.24, SD=2.73$) compared to Hispanic or Latina/o/e non-transfer students (HL-nT; $M=12.19, SD=2.12$) and non-Hispanic or Latina/o/e non-transfer students (nHL-nT; $M=12.52, SD=2.25$) (see Figure 1).

Scientific Significance

Although we are only in the first year of this project, results already demonstrate the impact of implementing these class activities for fostering student SRL and motivational processes for the target minoritized group we focus on for this grant: transfer students who identify as Hispanic or Latina/o/e. These students had the highest scores on the Mastery-Approach subscale of the AGQ-R. This indicates that not only are we already on the way to reaching our goal for the grant, we are also ensuring these students have the goal to master content in their courses and are not focusing too much on their grades. It is important to note that the sub-scales of the AGQ-R are mutually exclusive. Therefore, just because students score high on one sub-scale, this does not mean they are automatically scoring low on the others. As such, we do not conclude these students are not focusing on their grades at all, which is important because students need to find the balance between achieving content mastery in their classes while also receiving good grades to maintain a high GPA so they can continue to achieve in college and in their future careers.

Correlations demonstrated large significant positive relationships between student reported SRL, achievement goals, and general self-efficacy. However, the significance changed when we examined coefficients by group. From these results, perhaps Hispanic or Latina/o/e transfer students are more likely to self-report their ability to achieve in their courses based on both mastering the course material and getting a good grade (i.e., combined mastery- and performance-oriented goal orientation), as their GSE scores were correlated with both mastery- and performance-approach scores. For non-Hispanic or Latina/o/e transfer students, perhaps their perceived metacognitive strategy-use is strongly related to them mastering the content, as their MSLQ scores were correlated with mastery approach and avoidance scores. Transfer students may be more motivated because they are more aware of the financial responsibilities related to being enrolled in college courses or have had to put more effort into being enrolled in their current courses. Additionally, they may be aware of the differences from their current and previous institution and know they need more *self*-regulation than before. However, both transfer groups had the highest correlation coefficient between performance-approach and performance-avoidance orientations. Thus, it seems all transfer students focus on maintaining good grades as well.

From these results, it is likely if as instructors, we target increasing students' perceptions of the use of self-regulatory skills, we are likely positively influencing their self-reported

² The one-way MANOVA violated Box's M; $p < .05$

motivations as well. Groups had stronger correlations between some variables over other groups, however we anticipate these trends to increase for all students as they continue to take courses that implement these activities that foster SRL and motivation. Future studies will continue to examine these associations, including comparing scores: across semesters that implemented the activities, across semesters that did vs. did not implement the activities, and within semesters from the same student pre and post activity.

Future studies will also incorporate course performance by investigating the relationship between student SRL, motivations, and course outcomes among transfer or non-transfer students who do or do not identify as Hispanic or Latina/o/e. We will also conduct student interviews to gauge their perceptions of course activities and their reported levels of SRL and motivations. During the interviews, we will collect multimodal data channels (Azevedo & Gasevic, 2019) to capture students' real-time affective responses as they describe their course perceptions, including facial expressions of emotion or galvanic skin response.

We want to ensure *all* students are succeeding in their courses—including transfer students who identify as Hispanic or Latina/o/e—so we can adapt to their individual student needs to make them better self-regulators and thus more successful in their STEM courses and future careers.

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Tables and Figures

Table 1.

Pearson Correlation Coefficient (r) between All Questionnaire Responses.

	1MSLQ	2GSE	3MApP	4MAv	5PApP	6PAv
1	-	.517***	.415***	.313***	.286***	.161*
2		-	.514***	.362***	.414***	.254***
3			-	.515***	.505***	.311***
4				-	.694***	.691***
5					-	.685***
6						-

*** $p < .001$, * $p < .05$

1MSLQ = Motivated Strategies for Learning Questionnaire; 2-GSE = General Self-Efficacy; 3-MApP = Mastery Approach; 4-MAv = Mastery Avoidance; 5-PApP = Performance Approach; 6-PAv = Performance Avoidance.

Table 2.

Pearson Correlation Coefficients (r) between MSLQ, AGQ-R, and GSE scores for Hispanic or Latina/o/e Transfer Student Groups.

	1MS LQ	2GSE				3MApP				4MAv				5PApp				6PAv			
1	-	.44 *	.57* **	.57* **	.52* **	.19	.40* *	.58* **	.41* **	.36	.13	.43* *	.31* *	.33	.34*	.24	.32* *	.30	.15	-.045	.25*
2			-			.65* **	.44* *	.52* **	.49* **	.42 *	.26	.35* *	.41* **	.66* **	.40**	.25	.45* **	.31	.27	.12	.33* *
3							-			.40 *	.31 *	.69* **	.59* **	.50* **	.45**	.61* **	.50* **	.32	.13	.26	.44* **
4											-			.68* **	.69** *	.82* **	.60* **	.80* **	.53* **	.64* **	.71* **
5															-			.72* **	.56* **	.72* **	.68* **

*** $p < .001$, ** $p < .0125$ [$*p < .05$ is no longer significant due to adjusted α]. Highest r value for each correlation is in red-bold, significant is in bold.

1MSLQ = Motivated Strategies for Learning Questionnaire; 2-GSE = General Self-Efficacy; 3-MApP = Mastery Approach; 4-MAv = Mastery Avoidance; 5-PApp = Performance Approach; 6-PAv = Performance Avoidance.

*Note. Grey = HL-T (Hispanic or Latina/o/e Transfer students); White = HL-nT (Hispanic or Latina/o/e non-Transfer students); Blue = nHL-T (non-Hispanic or Latina/o/e Transfer students); Orange = nHL-nT (non-Hispanic or Latina/o/e non-Transfer students).

Table 3.

Mean Rank Scores and Kruskal-Wallis Results for Self-Reported MSLQ, GSE, and AGQ-R.

	<u>HL (n=72)</u>		<u>nHL(n=152)</u>		Kruskall-Wallis	
	HL-T (n=29)	HL- nT(n=43)	nHL- T(n=56)	nHL- nT(n=96)		
	Mean Rank	Mean Rank	Mean Rank	Mean Rank	H	Post-hoc
MSLQ	123.38	105.47	123.38	106.02	3.875	1=2=3=4
GSE	120.72	109.35	111.02	112.29	.604	1=2=3=4
MApp	138.76	95.50	118.65	108.59	8.933*	1=3,1>2**,4*
MAv	90.90	102.12	119.77	119.44	6.235	1=2=3=4
PApp	93.09	101.27	119.97	119.04	5.814	1=2=3=4
PAv	92.31	98.87	122.08	119.11	7.285	1=2=3=4

** $p < .01$, * $p < .05$

HL-T = Hispanic or Latina/o/e Transfer students; HL-nT = Hispanic or Latina/o/e non-Transfer students; nHL-T = non-Hispanic or Latina/o/e Transfer students; nHL-nT = non-Hispanic or Latina/o/e non-Transfer students.

MSLQ = motivated strategies for learning questionnaire (range 1.86-7); GSE = general self-efficacy questionnaire (range 10-40); AGQ-R = achievement goals questionnaire – revised; MApp = mastery approach (range 3-15); MAv = mastery avoidant (range 3-15); PApp = performance approach (range 3-15); PAv = performance avoidant (range 3-15).

*Note. MApp, MAv, PApp, PAv are all subscales of the AGQ-R. All $df = 3$ for Kruskal-Wallis tests.

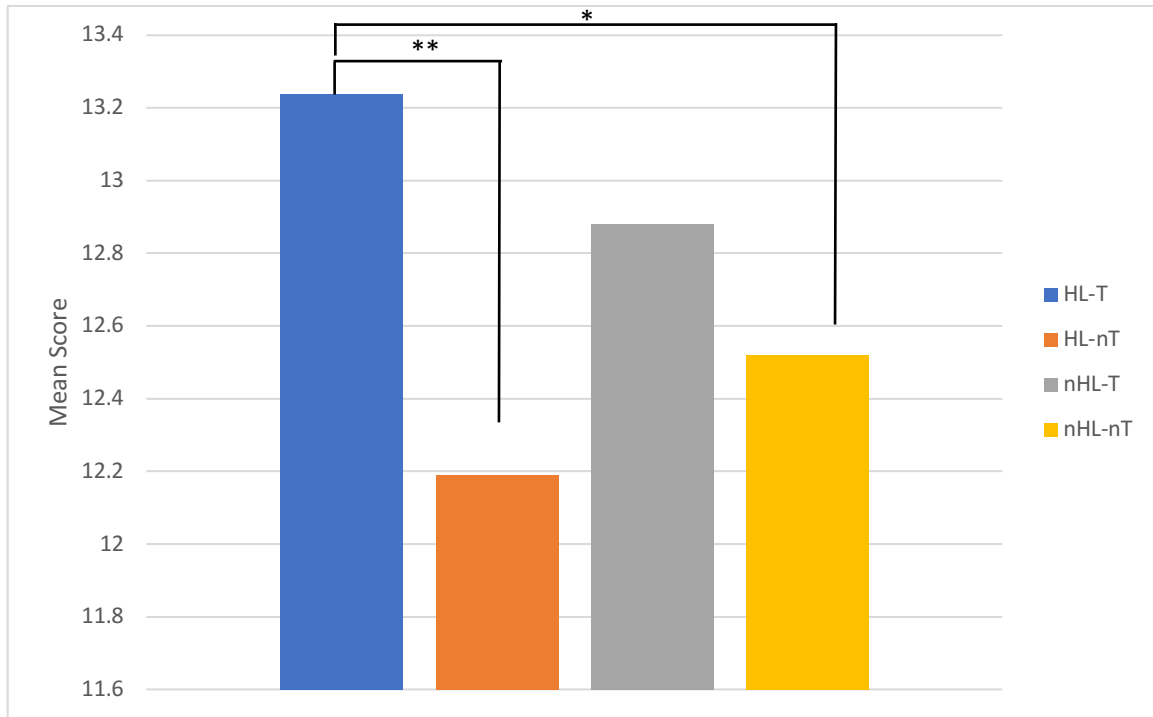


Figure 1. Mean Scores for AGQ-R – Mastery-Approach Sub-Scale across Student Groups.

****** $p < .01$, ***** $p < .05$.

HL-T = Hispanic or Latina/o/e Transfer students; HL-nT = Hispanic or Latina/o/e non-Transfer students; nHL-T = non-Hispanic or Latina/o/e Transfer students; nHL-nT = non-Hispanic or Latina/o/e non-Transfer students.

AGQ-R = achievement goals questionnaire – revised.